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COMMENTS ON FOUR LEGUMES (*CLITORIA, CENTROSEMA*) REPORTED AS OCCURRING IN INDIA

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ABSTRACT

The South American species, *Clitoria arborescens* R. Br. in Ait., reported as new to India by Bhaumik and Das in 1983 was a misidentification. The plant belongs to a variety of *Clitoria mariana* L. which is newly described as var. ***orientalis*** Fantz. *Centrosema virginianum* (L.) Benth. reported by Subramanian in 1961 was a misidentification for *Centrosema pubescens* Benth. The authors question the validity of the conclusion proposed by Almeida and Almeida that *Clitoria annua* J. Graham (the name with priority) is equivalent to *Clitoria biflora* Dalz., but have no evidence to refute it. *Clitoria vaupellii* J. Graham is best treated as ambiguous since there is a lack of evidence as to its identity.

The Botanical Survey of India is sponsoring a taxonomic treatment of the genus *Clitoria* (Leguminosae) in India. Several recent publications on species occurring in India have promoted taxonomic confusion within this genus. Members of the South American species, *Clitoria arborescens* R. Br. in Ait., were reported by Bhaumik and Das (1983) as a new wild species in India. Subramanian (1961) reported *Centrosema virginianum* (L.) Benth. (syn. *Clitoria virginiana* L.) as an escaped ornamental introduction. Graham (1839) described two new species from India, *Clitoria annua* J. Graham and C. *vaupellii* J. Graham, neither name appearing in standard taxonomic references. The objectives of this article are (1) to correct the misidentifications made by Bhaumik and Das (1983) and Subramanian (1961), and (2) to discuss Graham's taxa.

CLITORIA ARBORESCENS REPORTED IN INDIA

Bhaumik and Das (1983) reported *Clitoria arborescens* R. Br. in Ait. as a new record from India (Khasi Hills) based upon the voucher *Bhaumik 60481* (ASSAM, CAL). Fantz examined and annotated a flowering specimen of *Bhaumik 60481* (CAL) on loan and returned in 1984. Also examined was a photograph of

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a fruiting specimen of *Bhaumik 60481* sent as a gift and later deposited at the University of Florida Herbarium (FLAS 151252). Dr. Bhaumik (pers. comm., 1984) indicated that he did not accept Fantz's conclusion that the specimen was misidentified. Predeep could not locate *Bhaumik 60481* in 1990 in either ASSAM or CAL. Predeep discussed the specimen with Dr. Bhaumik who is now uncertain regarding the location of his specimens. The photograph (FLAS) was re-examined by Fantz in 1990 along with data recorded from the specimen in 1984. This specimen is misidentified and belongs to *Clitoria mariana* L.

Fantz has examined and annotated over 8,000 specimens of *Clitoria. Clitoria arborescens* is distributed in northern South America, from French Guiana to eastern Venezuela with isolated collections from Colombia and northern Venezuela. It is distinguished easily from the plant described by Bhaumik and Das (1983) by elongated inflorescences with larger flowers and elongate, flat fruits. *Clitoria arborescens* does not occur in the Old World.

Clitoria macrophylla Wall. ex Benth. often is confused in Asian collections with *C. mariana*. *Clitoria macrophylla,* however, is distinguished easily by the contracted inflorescences of smaller, white flowers, and elongated calyx lobes, bracts, bracteoles and fruits. Table 1 contrasts the plant described by Bhaumik and Das (1983) with *C. arborescens, C. macrophylla* and *C. mariana. Bhaumik 60481* is *C. mariana,* not *C. arborescens* or *C. macrophylla.*

Clitoria mariana has a disjunct distribution, occurring in North America and Southeast Asia. Bentham (1858) noted that the Asian element is more luxurient when compared to American members. Fantz (1979) concluded that the Asian element repesents a subspecific entity, not a distinct species. This taxon is newly described as follows:

Clitoria mariana L. var. **orientalis** Fantz. var. nov.

Varietas nova optimo distinguitur a stipitibus, gynophoris et alis brevior, stipulis et alis latior, et inflorescentis longior.

TYPE: Sina. Yunnan: Szemao, 5500 ft., *Henry 12242* (HOLOTYPIS: E; ISOTYPIS: K, MO 107074, NY-hb. Henry). PARATYPIS: l.c., 4500 ft, *Henry 12242A* (CAL, NY-2 sheets); [Yunnan:] Doi Angká, Doi Pá Mawn, ca 1640 m, 30 Jun 1927, *Garrett B394* (BM).

Variety *orientalis* is slightly more robust in stature than the typical variety with larger leaflets, longer petioles and stipules 3 – 5 mm wide. The inflorescences are 2 – 4-(8-) flowered, with the peduncle 1 – 6 cm long, subarcuate and weakly stiff, becoming slender and subtwining at upper nodes, elongating to 15 cm long. Flowers exhibit wings extending beyond the keel by 3 – 5 mm with the blade 13 – 16 mm long and 3 – 6 mm wide. Gynophores are 2 – 4 mm long in flower becoming 5 – 8 mm long stipes in fruit.

Stems of young plants of var. *orientalis* are suberect to nearly prostrate with weakly zigzag to nearly straight internodes, with the upper portion of the stem soon exhibiting the twining appearance. Xylopodia collected appear similar to

TABLE 1. Comparison of some morphological characters of Bhaumik's plant with *Clitoria arborescens, C. mariana* and *C. macrophylla.*

CHARACTER	Bhaumik's Description	*Clitoria arborescens*	*Clitoria mariana*	*Clitoria macrophylla*
LEAVES:				
Adaxial Veins	Uncinate pubescent	Glabrous	Uncinate pubescent	Uncinate pubescent
Abaxial Pubescence	Strigose	Rufotomentose	Strigose to glabrate	Sericeous to strigose
Petiolule Length	5 – 6 mm	6 – 9 mm	4 – 6 mm	4 – 6 mm
INFLORESCENCE:				
Number of Flowers	Few-flowered	Multiflowered	Few-flowered	Several-flowered
Bracteole Length	8 mm	10 – 15 mm	4 – 9 mm	7 – 12 mm
Pedicel Length	3 – 5 mm	5 – 9 mm	3 – 7 mm	3 – 6 mm
FLOWERS:				
Standard Color	Violaceous	Violaceous	Violaceous	White
Calyx Tube Length	18 – 20 mm[1]	12 – 17 mm	10 – 14 mm	9 – 12 mm
Calyx Tube Width	6 – 9 mm	8 – 11 mm	5 – 8 mm	5 – 8 mm
Calyx Lobe Length	4 mm, long acumen[2]	5 – 8 mm	5 – 8 mm	9 – 15 mm
Ovary Length	7 mm	15 – 18 mm	7 – 9 mm	7 – 9 mm
FRUIT:				
Stipe Length	12 mm	14 – 20 mm	12 – 17 mm	6 – 9 mm
Fruit Length	3.5 – 6.5 cm	16 – 23 cm	3 – 7 cm	4 – 5.5 cm
Fruit Curvature	Convex	Flat	Convex	Convex

[1]*Bhaumik 60481* (CAL), calyx tube was measured as 11 – 14 mm long; we believe that Bhaumik & Das description cited is measurement of calyx length (tube plus lobes), not tube length.
[2]*Bhaumik 60481* (CAL), calyx lobe length was measured as 6 – 8 mm long, including length of broadened base plus acumen; we believe that Bhaumik & Das description cited does not include the acumen portion in the length.

the American variety. Lower leaves have shorter petioles and leaflets that are similar to the American variety. Climbing portions often exhibit much larger leaflets and longer petioles. Inflorescences borne on lower nodes have somewhat stiff, shorter axes, commonly 2-flowered apically. These are similar to the American variety. Upper nodes frequently bear inflorescences that are more slender, elongated, sometimes somewhat twining bearing apically 4 flowers or occasionally 6 – 8 flowers.

The E specimen designated as the holotype has a mature, viney section of the stem with the typical broader stipules, longer petiolate leaves, and slender 4-flowered inflorescences borne on slightly elongated axes. The isotype from MO is similar; however, those specimens from K and NY represent lower stem portions with associated characteristics.

TABLE 2. Comparison of some morphological characters of Subramanian's taxon with characteristics distinguishing *Centrosema pubescens* and. *C. virginianum.*

CHARACTER	Subramanian's Taxon	Centrosema pubescens	Centrosema virginianum
LEAVES:			
Petiolule Length	—	3 – 4 mm	2 – 3 mm
Stipel Length	—	2 – 4 mm	4 – 7 mm
INFLORESCENCE:			
Axis Length	4 – 5 cm	2 – 7 (9) cm	0.5 – 2 cm
Bract Length	6 – 7 mm	6 – 7 mm	3 – 4 mm
Pedicel Length in flower	5 mm	5 – 8 mm	2 – 5 mm
Pedicel Length in fruit	—	8 – 13 mm	4 – 8 mm
CALYX			
Upper & Lateral Teeth	ca 4 mm, subequal length of tube[1]	2 – 4 mm, subequal length of tube	6 – 8 mm, much longer than length of tube
Ventral Tooth Length	6 mm	5 – 8 mm	8 – 10 mm
LEGUME			
Valve Width	6 – 8 mm	6 – 8 mm	4 – 5 mm
Beak Length	10 – 15 mm[2]	8 – 10 mm	10 – 15 mm
Indumentum	Sparingly puberulous	Glabrate	Puberulent
Valve Dehiscence	ca 1 – $1^1/_4$ spiral turns	1 – $1^1/_2$ spiral turns	$1^1/_2$ – 3 spiral turns

[1]Characteristic expressed based upon Subramanian's illustration of the taxon, not his description.
[2]Illustration of two fruits has beak length measurement as ca 8 – 10 mm.

Henry 12242A is designated a paratype since it was collected from the same vicinity as the holotype, but at a lower elevation. Floral examination is difficult as the large flowers are glued to the herbarium sheet in most collections of *Clitoria. Garrett 394* (BM) is designated as a paratype because it bears a dissected flower in the packet glued to the herbarium sheet.

Variety *mariana* has stipules 1 – 3 mm wide. The inflorescences are stout, 2-flowered (rarely 4-flowered), with the peduncle typically stout and straight, and 1 – 4 cm long (rarely 6 – 9 cm long). Flowers exhibit wings extending beyond the keel by 7 – 12 mm with the blade 21 – 24 mm long and 5 – 10 mm wide. Gynophores are 5 – 8 mm long in flower becoming 12 – 17 mm long stipes in fruit. It occurs in the United States of America with two collections known from adjacent Mexico.

SUBRAMANIAN'S MISIDENTIFICATION

Subramanian (1961) reported that an introduction of *Centrosema virginianum* in the early 19th century had escaped and become naturalized in the forests of Kerala and elsewhere in India. Thothathri and Prasad (1970) extended the range to Pasighat, 24 Parganas, West Bengal. Several regional floras of Indian states or districts follow Subramanian.

Subramanian provided an excellent description and illustration of his plant, one that easily indicates it is misidentified. His plant is *Centrosema pubescens* Benth. Both species are morphologically plastic in their vegetative characteristics. Neotropical specimens are often misidentified as the other species. Table 2 contrasts distinguishing characteristics of these two species. *Centrosema virginianum* is not known to occur in India based upon Predeep's investigation of herbarium specimens (ASSAM, BLAT, BSA, BSD, BSI, BSIS, BSJO, CAL, CALI, DD, MH).

GRAHAM'S TAXA

John Graham (1839) listed four species (no. 351 – 354) of *Clitoria* in his catalogue as *C. ternatea, C. brasiliana, C. annua* G., and *C. vaupellii* G. respectively. Two of Graham's species are correctly known today as *C. ternatea* L. and *Centrosema brasilianum* (L.) Benth. (syn. *Clitoria brasiliana* L.). The other two species were newly described with a brief diagnosis by John Graham.

John Graham's diagnoses are ambiguous and were described as "sketchy" by Burkill (1965) in his work on Indian botanical history. Examination of Graham's herbarium collections would provide insight into his circumscription of the new species. However, the present location of Graham's herbarium and types are unknown according to Stafleu and Cowan (1976).

The circumscription of *Clitoria* was applied more broadly in John Graham's era and included species that are now recognized as belonging to several other genera (e.g. *Centrosema, Galactia, Periandra*). The two known plants listed by John Graham (*C. ternatea and C. brasiliana*) are assigned presently to different genera, *Clitoria* and *Centrosema* respectively. We believe that there exists the possibility that Graham's two new taxa may also belong to *Centrosema* or to another genus.

Clitoria annua was listed in Graham's catalogue as "Herbaceous, annual species. - Common on Malabar Hill &c. during the rains." Almeida and Almeida (1987) noted that "there is only one erect herbaceous species of this genus [*Clitoria*] found within the present boundaries of India" and they found plants of *C. biflora* Dalz. growing on Malabar Hill. Almeida and Almeida (1987) described *C. biflora* as "stems suberect, angular, petioles very short, leaflets 5, flowers blue, 2-flowered, bracteoles large." This description is based upon Dalzell and Gibson (1861) and has some diagnostic characteristics, none of which were noted in Graham's diagnosis (e.g., an erect habit).

Almeida and Almeida (1987) proposed that the name *C. annua* Graham be recognized as the correct name for the Indian endemic presently known as *C. biflora* Dalz. They concluded (1) that "Graham's binomial and diagnostic description of the taxon are sufficient for the identification of the species," (2) that there is only one erect herbaceous species of *Clitoria* in India and a typical specimen has been collected from Malabar Hill in 1986 (*Almeida 5890,* BLAT), (3) that Graham's species is equivalent with Dalzell's species, and (4) "according to Article No. 32.2 of ICBN, Dalzell's *Clitoria biflora* should be a synonym."

Clitoria heterophylla Lam. commonly is described as a herbaceous annual. It is known to have been in cultivation in western India since 1815. Could John Graham's plant be *C. heterophylla* introduced onto Malabar Hill or possibly some other species from a genus such as *Centrosema* that was included in de Candolle's circumscription of *Clitoria?* We question the validity of the arguments leading to the conclusion that Graham's taxa is a true *Clitoria* and an erect herbaceous species, but without any evidence to the contrary, reluctantly accept the argument proposed by Almeida and Almeida.

The identity of *C. vaupellii* still remains a mystery. *Clitoria vaupellii* J. Graham was cited as "A suffruticose, erect and growing, much branched species: in Mr. Vaupell's garden, at Bandora." Three of the species of *Clitoria* as listed by Graham (1839) are known to be in cultivation. *Centrosema brasilianum,* native to South America, and *Clitoria ternatea,* native to East Africa, were introduced into India. The only known erect, suffruticose species of a true *Clitoria* known from India at this time was a voucher (E: Calcutta, *B.C.D. s.n.*) collected in 1830 of *Clitoria laurifolia* Poir. It would be pure speculation without any hard evidence to equate these two names as synonymous. We find the description lacking diagnostic characters for identification in view of the present knowledge of the circumscription of *Clitoria* and its taxa. The name *C. vaupellii* J. Graham is best treated taxonomically as ambiguous or dubious.

ACKNOWLEDGMENTS

Appreciation and thanks are extended to Drs. James Hardin and Jon Stucky for their critical review and recommendations for this manuscript, to Dr. Bhaumik for his cooperation, and to the curators of the herbaria cited in this paper.

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BOOK REVIEWS

ISELY, DUANE. Leguminosae (Fabaceae). 1990. In: Vascular Flora of the Southeastern United States. Vol. 3, Part 2. The University of North Carolina Press, Chapel Hill. 258 pp. $35.00.

This is the second issue in the series *Vascular Flora of the Southeastern United States*. From the Editor's Notes: "Because of the importance and size of this family, we have elected to treat these plants in a separate volume. To place this in taxonomic sequence, it is assigned as Volume 3, Part 2."

The Introduction has sections on 1) The Southeastern United States, 2) Classification and Nomenclature, and 3) About the Text.

The taxonomic treatment in this text consists of a single family and three subfamilies. Keys to subfamilies, genera of the subfamilies, and to species are included with excellent descriptions of the taxa. The keys to genera of the subfamilies are accompanied by diagrammatic illustrations.

"Appendix 1 – Selected Bibliographies" has the references sorted into 1) General References to Leguminosae, 2) Floristic Treatments of Leguminosae of the United States, 3) References to Cultivated Species, and 4) Horticultural Tree and Shrub References.

"Appendix 2 – Systematics of the Leguminosae" is divided into two areas, 1) Historical Accounting of Legume Classification and 2) Classification of Legumes in the Southeastern United States.

The appendices are followed by separate chapters: 1) Symbols, 2) Glossary, 3) Literature Cited, and 4) Index.

This is the first comprehensive treatment of the legumes of the southeastern United States since 1933 when they were treated in the edition of Small's "Manual of the southeastern flora." This volume is a valuable addition for the identification of the legumes of the southeastern United States. Appendix 2 is an excellent discourse on classification. This book should be in every herbarium as a standard reference for this family. *Wm. F. Mahler.*

CRAWFORD, DANIEL J. 1990. Plant Molecular Systematics: Macromolecular Approaches. John Wiley & Sons, New York. Hardbound $49.95. 388 pp.

Although the use of molecular information in systematic studies has been available in excess of thirty years, plant systematists have consistently applied such techniques for only about half that time. Despite the now-common usage of enzyme electrophoresis and various DNA protocols, no text provided a historical perspective of plant molecular systematics until Crawford's book. Topics covered in this volume include electrophoresis of various plant proteins, enzyme electrophoresis, systematic serology, nuclear, nuclear ribosomal, and chloroplast DNA studies and their contributions to the current understanding of vascular plant evolution. The real value of this book lies in Crawford's clearly-conveyed rationale for the limitations and strengths of various molecular methods. His examples, taken from published literature, are classic illustrations of the insights gained through the compilation of numerous research efforts. While *Plant Molecular Systematics* may never garner popular appeal, it should be required reading for any student contemplating work in plant systematics. Other individuals interested in understanding current trends in plant evolutionary theory would do well to look at it, too. The reference section is an invaluable resource, making one willing to overlook the numerous typographical errors, which, I hope, will be corrected in future editions, and even takes some of the sting out of the publisher's price. *Nancy Cowden.*

OLD WORLD GENERA OF THE PANICEAE (POACEAE: PANICOIDEAE)

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ABSTRACT

Seventy-nine genera of the Paniceae are recognized as occurring in the Old World. For each genus a complete set of taxonomic data was collected and based on observations of all available specimens. The data were analyzed to construct a bracketed key for the genera. The fifty most diagnostic characters were selected and used in the production of fully comparative descriptions for the genera.

INTRODUCTION

This paper represents the final in a series of reports originally designed to provide a comprehensive taxonomic account of the genera of the Paniceae on a worldwide basis. The genera were studied and treated on a geographical basis. Initially, Webster (1988) presented a revision of the 25 North American genera which included *Alloteropsis* Presl, *Amphicarpum* Kunth, *Anthaenantia* P. Beauv., *Anthephora* Schreb., *Axonopus* P. Beauv., *Brachiaria* (Trin.) Griseb., *Cenchrus* L., *Digitaria* Haller, *Echinochloa* P. Beauv., *Eriochloa* Kunth, *Hymenachne* P. Beauv., *Lasiacis* (Griseb.) Hitchc., *Melinis* P. Beauv., *Oplismenus* P. Beauv., *Panicum* L., *Paspalidium* Stapf, *Paspalum* L., *Pennisetum* Rich., *Phanopyrum* (Raf.) Nash, *Reimarochloa* Hitchc., *Rhynchelytrum* Nees, *Sacciolepis* Nash, *Setaria* P. Beauv., *Stenotaphrum* Trin. and *Urochloa* P. Beauv. The revision gave information on the methods employed to present the taxonomic results and a detailed discussion of character concepts. The taxonomic results consisted of a key to the genera, synopsis of the characters, comparative diagnostic descriptions, and discussion of the generic variation.

That paper was followed by Webster and Valdez (1988) which provided a taxonomic account of the 38 Mesoamerican Paniceae genera which included *Acroceras* Stapf, *Anthaenantia* P. Beauv., *Anthephora* Schreb., *Arthropogon* Nees, *Axonopus* P. Beauv., *Brachiaria* (Trin.) Griseb., *Cenchrus* L., *Chaetium* Nees, *Digitaria* Haller, *Echinochloa* P. Beauv., *Echinolaena* Desv., *Eriochloa* Kunth, *Homolepis* Chase, *Hymenachne* P. Beauv., *Ichnanthus* P. Beauv., *Isachne* R. Br., *Ixophorus* Schlecht., *Lasiacis* (Griseb.) Hitchc., *Melinis* P. Beauv., *Mesosetum* Steud., *Oplismenus* P. Beauv., *Panicum* L., *Paratheria* Griseb., *Paspalidium* Stapf, *Paspalum* L., *Pennisetum* Rich., *Pseudechinolaena* Stapf, *Reimarochloa* Hitchc., *Reynaudia*

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Kunth, *Rhynchelytrum* Nees, *Sacciolepis* Nash, *Scutachne* A. Hitchc. & Chase, *Setaria* P. Beauv., *Setariopsis* Scribn. & Millsp., *Stenotaphrum* Trin., *Thrasya* Kunth, *Triscenia* Griseb. and *Urochloa* P. Beauv. The treatment consisted of an introduction, additional information on methods, English key, Spanish key, a synopsis in Spanish, comparative diagnostic descriptions, and remarks on the genera. Descriptions covered by Webster (1988) were not duplicated. A total of 16 new descriptions were presented and were comparable to the 25 in Webster (1988).

That paper was followed by Webster et al. (1989) which provided a taxonomic account of the 50 recognized genera occurring in the New World. In hard copy, the paper contained additional information on the specific methods used, a cumulative description of the tribe, an identification key, and complete set of synoptic descriptions. An accompanying microfiche contained the English, Spanish, and Portuguese versions of the character list, keys, and complete descriptions for all taxa.

As a result of continuing taxonomic studies of the genera of the Paniceae a complete set of data of the genera of the world has been gathered. A detailed discussion of character reliability and morphological similarity among the 102 recognized genera is provided in Webster (1992). It is appropriate at this time to make available the taxonomic data for the Old World genera. The objective of this paper is to present a key and set of comparative diagnostic descriptions for the Old World genera. Information presented here fully compliments published studies on the New World genera. In addition, many of descriptions presented in this paper contains comparable information which previously has not been available for the genera. As in previous studies the DELTA system (Dallwitz 1974 & 1980) was used for the gathering and presentation of data. Seventy-nine genera were recognized as occurring in the Old World. The fifty most diagnostic characters were chosen to construct the descriptions. To avoid duplication, descriptions are not given for genera treated in previous papers. For these 26 genera (*Acroceras* Stapf, *Alloteropsis* Presl, *Anthephora* Schreb., *Axonopus* P. Beauv., *Brachiaria* (Trin.) Griseb., *Cenchrus* L., *Digitaria* Haller, *Echinochloa* P. Beauv., *Echinolaena* Desv., *Eriochloa* Kunth, *Hymenachne* P. Beauv., *Ichnanthus* P. Beauv., *Isachne* R. Br., *Melinis* P. Beauv., *Oplismenus* P. Beauv., *Panicum* L., *Paratheria* Griseb., *Paspalidium* Stapf, *Paspalum* L., *Pennisetum* Rich., *Pseudechinolaena* Stapf, *Rhynchelytrum* Nees, *Sacciolepis* Nash, *Setaria* P. Beauv., *Stenotaphrum* Trin., and *Urochloa* P. Beauv.) that occur in both the old and new worlds references are given to previously published comparative descriptions.

KEY TO THE OLD WORLD GENERA OF THE PANICEAE

1(0). Rachis terminating in a spikelet 2
Rachis terminating in a bristle or an unmodified naked point 76
2(1). Disarticulation above the lower glume or at the spikelet base 3

Disarticulation at the base of the primary branches or at the nodes of the primary branches 70
3(2). Fertile florets 1 4
Fertile florets 2 68
4(3). Inflorescence a panicle 5
Inflorescence a raceme 58
5(4). First glume fused with the callus to form a cuplike structure ..... *Eriochloa*
First glume not fused with the callus 6
6(5). Lemma of upper floret muticous 7
Lemma of upper floret awned 55
7(6). Lemma of upper floret glabrous 8
Lemma of upper floret hairy 52
8(7). Cleistogamous inflorescence present ..... *Cleistochloa*
Cleistogamous inflorescence absent 9
9(8). Lemma of upper floret with flat margins 10
Lemma of upper floret with involute margins 27
10(9). Lemma of lower floret with a hyaline area at the base or with the area between the central nerve and the first lateral nerve thinner in texture than the rest of the structure 11
Lemma of lower floret consistent in texture 13
11(10). Second glume gibbose; main axis with distichous primary branches; spikelets laterally compressed; rachilla pronounced between the florets ..... *Pseudechinolaena*
Second glume rounded on the back; main axis with quaquaversal primary branches; spikelets dorsiventrally compressed or planoconvex; rachilla not pronounced between the florets 12
12(11). First glume encircling the spikelet base; lemma of lower floret with a central longitudinal groove; second glume chartaceous ..... *Thyridachne*
First glume not encircling the spikelet base; lemma of lower floret lacking a central longitudinal groove; second glume membranous ..... *Megaloprotachne*
13(10). Spikelets laterally compressed 14
Spikelets dorsiventrally compressed or planoconvex 18
14(13). Ligule a membrane or a ciliate membrane 15
Ligule a fringe of hairs 16
15(14). Pedicels concave; spikelets abaxial; first glume encircling the spikelet base; lemma of upper floret cartilaginous or indurate ..... *Homopholis*
Pedicels flat, or convex; spikelets adaxial; first glume not encircling the spikelet base; lemma of upper floret hyaline ..... *Cyphochlaena*
16(14). Main axis with secund primary branches; primary branches spreading; first glume hairy ..... *Rhynchelytrum*
Main axis with quaquaversal primary branches; primary branches appressed to the main axis; first glume glabrous 17
17(16). Primary branches with appressed secondary branches; plants andromonoecious; lemma of lower floret muticous ..... *Lecomtella*
Primary branches with spreading secondary branches; plants hermaphroditic; lemma of lower floret awned ..... *Melinis*
18(13). Spikelets adaxial 19
Spikelets abaxial 24
19(18). Second glume saccate ..... *Sacciolepis*

Second glume rounded on the back 20
20(19). Pedicels perpendicular with the spikelet base; second glume muticous 21
Pedicels oblique to the spikelet base; second glume awned ..... *Acritochaete*
21(20). First glume present; primary branches with loosely arranged spikelets; rachilla pronounced below the second glume 22
First glume absent; primary branches with neatly arranged spikelets; rachilla not pronounced below the second glume ..... *Axonopus*
22(21). First glume encircling the spikelet base; plants perennial; lemma of upper floret with margins of the same texture as the body; C-3 23
First glume not encircling the spikelet base; plants annual; lemma of upper floret with margins thinner in texture than the body; C-4 ..... *Hylebates*
23(22). Rachilla pronounced between the florets; primary branches with spikelets neither secund nor distichous; pedicels cupuliform at the apex; lemma of upper floret yellow ..... *Microcalamus*
Rachilla not pronounced between the florets; primary branches with secund spikelets; pedicels discoid at the apex ..... *Hymenachne*
24(18). Lemma of upper floret chartaceous; lemma of lower floret awned ..... *Stereochlaena*
Lemma of upper floret cartilaginous or indurate; lemma of lower floret muticous 25
25(24). Lemma of upper floret with margins thinner in texture than the body; C-4 ..... *Digitaria*
Lemma of upper floret with margins of the same texture as the body; C-3 26
26(25). Primary branches with secund spikelets; rachilla not pronounced below the second glume; upper floret subequal to the length of the lower floret ..... *Ancistrachne*
Primary branches with spikelets not secund; rachilla pronounced below the second glume; upper floret 0.6 – 0.7 times the length of the lower floret ..... *Homopholis*
27(9). Second glume saccate 28
Second glume rounded on the back 29
28(27). Ligule a membrane; main axis with quaquaversal primary branches; spikelets abaxial; rachilla not pronounced between the florets ..... *Hydrothauma*
Ligule a fringe of hairs; main axis with secund primary branches; spikelets adaxial; rachilla pronounced between the florets ..... *Eccoptocarpha*
29(27). Lemma of upper floret hyaline to chartaceous 30
Lemma of upper floret cartilaginous to indurate 35
30(29). Ligule a membrane or a ciliate membrane 31
Ligule a fringe of hairs 34
31(30). Spikelets laterally compressed; upper floret more than 0.8 times the length of the lower floret; plants mesophytic 32
Spikelets not laterally compressed; upper floret less than 0.8 times the length of the lower floret; plants hydrophytic 33
32(31). Main axis with secund primary branches; lemma of upper floret not differentiated at the apex; lemma of lower floret keeled; lemma of upper floret shiny ..... *Poecilostachys*
Main axis with quaquaversal primary branches; lemma of upper floret differentiated at the apex; lemma of lower floret not keeled; lemma of upper floret dull ..... *Cyrtococcum*

33(31). Spikelets adaxial; first glume not encircling the spikelet base; primary branches spreading ..... *Louisiella*
Spikelets with lateral orientation to abaxial; first glume encircling the spikelet base; primary branches appressed to the main axis ..... *Hydrothauma*
34(30). Main axis with secund primary branches; rachilla not pronounced between the florets; plants annual ..... *Brachiaria*
Main axis with quaquaversal primary branches; rachilla pronounced between the florets; plants perennial ..... *Oryzidium*
35(29). Rachilla pronounced between the florets 36
Rachilla not pronounced between the florets 41
36(35). Lemma of upper floret with basal scars or appendages 37
Lemma of upper floret lacking basal scars or appendages 38
37(36). Pedicels concave; primary branches with loosely arranged spikelets; pedicels cupuliform at the apex; rachilla geniculate ..... *Ichnanthus*
Pedicels flat, or convex; primary branches with neatly arranged spikelets; pedicels discoid at the apex; rachilla straight ..... *Echinolaena*
38(36). Ligule a membrane or a ciliate membrane 39
Ligule a fringe of hairs 40
39(38). Primary branches with appressed secondary branches; spikelets adaxial; primary branches with secund spikelets; lemma of upper floret yellow ..... Acroceras
Primary branches with spreading secondary branches; spikelets ab-axial; primary branches with spikelets not secund; lemma of upper floret white ..... *Arthragrostis*
40(38). Plants hermaphroditic; spikelets not laterally compressed; lemma of lower floret consistent in texture; C-3 ..... *Yakirra*
Plants dioecious; spikelets laterally compressed; lemma of lower floret with a hyaline area at the base; C-4 ..... *Whiteochloa*
41(35). First glume present 42
First glume absent 49
42(41). Lemma of upper floret not rugose 43
Lemma of upper floret rugose 48
43(42). Pedicels concave 44
Pedicels flat or convex 47
44(43). Spikelets adaxial 45
Spikelets abaxial ..... *Ottochloa*
45(44). Spikelets laterally compressed ..... *Cyrtococcum*
Spikelets dorsiventrally compressed or planoconvex 46
46(45). Upper lemma conduplicate at the apex; pedicels truncate ..... *Acroceras*
Upper lemma becoming thinner in texture at the apex; pedicels discoid at the apex ..... *Echinochloa*
Upper lemma not differentiated at the apex; pedicels cupuliform at the apex ..... *Panicum*
47(43). Spikelets adaxial; first glume awned; pedicels discoid at the apex; C-3 ..... *Oplismenus*
Spikelets abaxial; first glume muticous; pedicels truncate at the apex; C-4 ..... *Paspalum*
48(42). Ligule a membrane; first glume not encircling the spikelet base; lemma of lower floret with a central longitudinal groove ..... *Holcolemma*
Ligule a fringe of hairs; first glume encircling the spikelet base; lemma of lower floret lacking a central longitudinal groove ..... *Urochloa*

49(41). Spikelets adaxial 50
Spikelets abaxial 51
50(49). Primary branches with loosely arranged spikelets; internodes hollow; palea of lower floret vestigial ..... *Yvesia*
Primary branches with neatly arranged spikelets; internodes solid; palea of lower floret absent ..... *Axonopus*
51(49). Primary branches with appressed secondary branches; pedicels flat to convex; callus not differentiated; primary branches with secund spikelets ..... Paspalum
Primary branches with spreading secondary branches; pedicels concave; callus differentiated; primary branches with spikelets not secund ..... *Tricholaena*
52(7). Cleistogamous inflorescence present; lemma of upper floret with margins thinner in texture than the body ..... *Cleistochloa*
Cleistogamous inflorescence absent; lemma of upper floret with margins of the same texture as the body 53
53(52). Spikelets adaxial; lemma of upper floret cartilaginous to indurate; plants rhizomatous 54
Spikelets abaxial; lemma of upper floret membranous; plants annual ..... *Sphaerocaryum*
54(53). Ligule a ciliate membrane; rachilla pronounced between the florets; lemma of upper floret with flat margins ..... *Microcalamus*
Ligule a fringe of hairs; rachilla not pronounced between the florets; lemma of upper floret with involute margins ..... *Entolasia*
55(6). First glume encircling the spikelet base 56
First glume not encircling the spikelet base 57
56(55). Lemma of upper floret hyaline; lemma of upper floret with flat margins; spikelets laterally compressed ..... *Mildbraediochloa*
Lemma of upper floret cartilaginous to indurate; lemma of upper floret with involute margins; spikelets dorsiventrally compressed ..... *Urochloa*
57(55). Spikelets adaxial; lemma of lower floret consistent in texture; ligule a membrane; pedicels oblique to the spikelet base ..... *Acritochaete*
Spikelets abaxial; lemma of lower floret with a hyaline area at the base; ligule a fringe of hairs; pedicels perpendicular with the spikelet base ... *Alloteropsis*
58(4). Cleistogamous inflorescence present 59
Cleistogamous inflorescence absent 60
59(58). Lemma of upper floret muticous; rachilla not pronounced between the florets ..... *Cleistochloa*
Lemma of upper floret awned; rachilla pronounced between the florets ..... *Calyptochloa*
60(58). Lemma of upper floret glabrous 61
Lemma of upper floret hairy 67
61(60). Lemma of upper floret hyaline to membranous 62
Lemma of upper floret chartaceous 63
Lemma of upper floret cartilaginous to indurate 64
62(61). Ligule a membrane or a ciliate membrane; callus not differentiated; pedicels flat to convex; Africa ..... *Snowdenia*
Ligule a fringe of hairs; callus differentiated; pedicels concave; Australia ..... *Neurachne*
63(61). First glume absent; ligule a membrane to a ciliate membrane; callus not differentiated ..... *Baptorhachis*

First glume present; ligule a fringe of hairs; callus differentiated ..... *Thyridolepis*
64(61). Callus differentiated; second glume chartaceous to indurate; plants xerophytic 65
Callus not differentiated; second glume hyaline to membranous; plants mesophytic 66
65(64). First glume with a transverse row of stout seta, the seta subtended by a hyaline area; glumes rounded to truncate ..... *Thyridolepis*
First glume lacking a transverse row of stout seta, the seta not subtended by a hyaline area; glumes acuminate to awned ..... *Paraneurachne*
66(64). Pedicels concave; rachilla not pronounced between the florets; lemma of upper floret with flat margins ..... *Ancistrachne*
Pedicels flat or convex; rachilla pronounced between the florets; lemma of upper floret with involute margins ..... *Echinolaena*
67(60). Spikelets adaxial; rachilla not pronounced between the florets; main axis with quaquaversal primary branches; plants perennial ..... *Entolasia*
Spikelets abaxial; rachilla pronounced between the florets; main axis with secund primary branches; plants annual ..... *Limnopoa*
68(3). Lemma of upper floret membranous ..... *Coelachne*
Lemma of upper floret chartaceous to indurate 69
69(68). Primary inflorescence branches with spreading secondary branches ..... *Isachne*
Primary inflorescence branches with appressed secondary branches ..... *Heteranthoecia*
70(2). Lemma of upper floret hyaline ..... *Chaetopoa*
Lemma of upper floret chartaceous 71
Lemma of upper floret cartilaginous to indurate 73
71(70). Callus differentiated; lemma of lower floret membranous; upper floret more than 0.8 times the length of the lower floret 72
Callus not differentiated; lemma of lower floret chartaceous; upper floret less than 0.8 times the length of the lower floret ..... *Trachys*
72(71). Spikelets adaxial; callus prolonged into a pronounced stipe; first glume chartilagineus ..... *Anthephora*
Spikelets abaxial; callus not prolonged into a stipe; first glumemembranous ..... *Tarigidia*
73(70). Inflorescence a panicle; spikelets abaxial; plants annual 74
Inflorescence a raceme; spikelets adaxial; plants perennial 75
74(73). Callus differentiated; rachilla not pronounced between the florets; spikelets 8 – 14 mm long ..... *Paractaenum*
Callus not differentiated; rachilla pronounced between the florets; spikelets 4 – 5 mm long ..... *Arthragrostis*
75(73). Cleistogamous inflorescence present; lemma of upper floret awned; pedicels concave; callus not differentiated ..... *Calyptochloa*
Cleistogamous inflorescence absent; lemma of upper floret muticous; pedicels flat to convex; callus differentiated ..... *Thuarea*
76(1). Inflorescence a panicle 77
Inflorescence a raceme 96
Inflorescence a spike or a solitary spikelet 98
77(76). Cleistogamous inflorescence present 78
Cleistogamous inflorescence absent 79
78(77). Disarticulation at the spikelet base; callus not differentiated; lemma of lower floret indurate ..... *Dissochondrus*

Disarticulation at the base of the primary branches; callus differentiated; lemma of lower floret membranous ..... *Paratheria*

79(77). Disarticulation at the spikelet base 80
Disarticulation at the base of the primary branches or at the nodes of the primary branches 84

80(79). Plants hermaphroditic 81
Plants monoecious ..... *Hygrochloa*
Plants andromonoecious ..... *Pseudochaetochloa*

81(80). First glume encircling the spikelet base 82
First glume not encircling the spikelet base 83

82(81). Main axis with distichous or with secund primary branches ..... *Paspalidium*
Main axis with quaquaversal primary branches ..... *Setaria*

83(81). Rachilla pronounced between the florets; lemma of lower floret lacking a central longitudinal groove ..... *Pseudoraphis*
Rachilla not pronounced between the florets; lemma of lower floret with a central longitudinal groove ..... *Holcolemma*

84(79). Lemma of upper floret muticous; lemma of lower floret lacking a central longitudinal groove 85
Lemma of upper floret awned; lemma of lower floret with a central longitudinal groove ..... *Uranthoecium*

85(84). Lemma of upper floret hyaline to membranous 86
Lemma of upper floret chartaceous 88
Lemma of upper floret cartilaginous to indurate 92

86(85). Main axis with distichous primary branches; lemma of lower floret linear to oblong ..... *Chamaeraphis*
Main axis with quaquaversal primary branches; lemma of lower floret lanceolate, ovate or elliptic 87

87(86). Plants hermaphroditic; rachilla pronounced between the florets; primary branches with secund spikelets; second glume lore than 0.8 times spikelet length ..... *Pseudoraphis*
Plants andromonoecious; rachilla not pronounced between the florets; primary branches with spikelets not secund; second glume less than 0.8 times spikelet length ..... *Pseudochaetochloa*

88(85). Plants hermaphroditic; upper floret perfect 89
Plants andromonoecious; upper floret staminate only ..... *Pseudochaetochloa*

89(88). Bristles unbranched 90
Bristles branched 91

90(89). Callus flared at the apex ..... *Cenchrus*
Callus not flared at the apex ..... *Pennisetum*

91(89). Callus differentiated; plants annual ..... *Chlorocalymma*
Callus not differentiated; plants perennial ..... *Odontelytrum*

92(85). Main axis with distichous or secund primary branches 93
Main axis with quaquaversal primary branches 94

93(92). Callus differentiated; first glume encircling the spikelet base; primary branches reflexed; plants lacking stolons ..... *Paractaenum*
Callus not differentiated; first glume not encircling the spikelet base; primary branches appressed to the main axis; plants stoloniferous ..... *Stenotaphrum*

94(92). Bristles subtending all spikelets; leaf blades filiform to linear 95
Bristles not subtending all spikelets; leaf blades ovate ..... *Streptolophus*

95(94). Callus flared at the apex ..... *Cenchrus*
Callus not flared at the apex ..... *Pennisetum*
96(76). Lemma of upper floret hyaline to membranous; callus not differentiated; rachilla pronounced between the florets ..... *Pseudoraphis*
Lemma of upper floret cartilaginous to indurate; callus differentiated; rachilla not pronounced between the florets 97
97(96). Flowering culms terminated by a solitary inflorescence; callus prolonged into a pronounced stipe ..... *Thuarea*
Flowering culms with inflorescences densely clustered in a spatheate panicle; callus not prolonged into a stipe ..... *Spinifex*
98(76). Callus differentiated; lemma of upper floret with flat margins; rachilla not pronounced below the second glume 99
Callus not differentiated; lemma of upper floret with involute margins; rachilla pronounced below the second glume ..... *Zygochloa*
99(98). Flowering culms with inflorescences in a spatheate raceme ..... *Xerochloa*
Flowering culms with inflorescences densely clustered in a spatheate panicle ..... *Spinifex*

DESCRIPTIONS FOR OLD WORLD GENERA OF THE PANICEAE

Acritochaete Pilger

Plants hermaphroditic; annual. Flowering culms terminated by a solitary inflorescence. Ligule a membrane. Inflorescence a panicle. Main axis with secund primary branches. Primary branches appressed to the main axis; with appressed secondary branches. Rachis terminating in a spikelet. Pedicels discoid at the apex; oblique to the spikelet base; flat. Disarticulation at the spikelet base. Callus not differentiated. Cleistogamous inflorescence absent. Spikelets solitary; homomorphic; adaxial; dorsiventrally compressed. First glume not fused with the callus; present; not encircling the spikelet base; not inflated at the base. Rachilla not pronounced below the second glume; not pronounced between the florets. Second glume present; rounded on the back; indumentum not uncinate. Fertile florets 1. Lemma of lower floret membranous; consistent in texture; lacking a central longitudinal groove. Lemma of upper floret chartaceous; faintly muricate; grey; dull; with flat margins; with margins thinner in texture than the body; glabrous; without basal modifications; not differentiated at the apex. C-4. Africa.

Acroceras Stapf—see WEBSTER & VALDEZ R. (1988).

Alloteropsis Presl—see WEBSTER (1988).

Ancistrachne S.T. Blake

Plants hermaphroditic; perennial. Flowering culms terminated by a solitary inflorescence. Ligule a ciliate membrane. Inflorescence a panicle, or a raceme. Main axis with quaquaversal primary branches. Primary branches appressed to the main axis to spreading; with appressed secondary branches. Rachis terminating in a spikelet. Pedicels cupuliform at the apex; perpendicular with the spikelet base; concave. Disarticulation at the spikelet base. Callus not differentiated.

Cleistogamous inflorescence absent. Spikelets solitary; homomorphic; abaxial; dorsiventrally compressed to planoconvex. First glume not fused with the callus; present; encircling the spikelet base; not inflated at the base. Rachilla not pronounced below the second glume; not pronounced between the florets. Second glume present; rounded on the back; indumentum uncinate. Fertile florets 1. Lemma of lower floret membranous to chartaceous; consistent in texture; lacking a central longitudinal groove. Lemma of upper floret cartilaginous to indurate; smooth (faintly striate); brown to yellow; dull; with flat margins; with margins of the same texture as the body; glabrous; without basal modifications; not differentiated at the apex. C-3. Asia and Australia.

Anthephora Schreb.—see WEBSTER & VALDEZ R. (1988).

Arthragrostis Lazarides

Plants hermaphroditic; annual. Flowering culms terminated by a solitary inflorescence. Ligule a ciliate membrane. Inflorescence a panicle. Main axis with quaquaversal primary branches. Primary branches spreading; with spreading secondary branches. Rachis terminating in a spikelet. Pedicels truncate at the apex; perpendicular with the spikelet base; concave. Disarticulation at the spikelet base and at the base of the primary branches. Callus not differentiated. Cleistogamous inflorescence absent. Spikelets solitary; homomorphic; abaxial; dorsiventrally compressed. First glume not fused with the callus; present; encircling the spikelet base; not inflated at the base. Rachilla pronounced below the second glume; pronounced between the florets; lacking lateral appendages. Second glume present; rounded on the back. Fertile florets 1. Lemma of lower floret membranous; consistent in texture; lacking a central longitudinal groove. Lemma of upper floret cartilaginous; smooth; white; dull; with involute margins; with margins of the same texture as the body; glabrous; without basal modifications; not differentiated at the apex. C-3. Australia.

Axonopus P. Beauv.—see WEBSTER (1988).

Baptorhachis Clayton & Renvoise

Plants hermaphroditic; annual. Flowering culms terminated by a solitary inflorescence. Ligule a ciliate membrane. Inflorescence a raceme. Rachis terminating in a spikelet. Pedicels truncate at the apex; perpendicular with the spikelet base; concave. Disarticulation at the spikelet base. Callus not differentiated. Cleistogamous inflorescence absent. Spikelets paired; homomorphic; abaxial; planoconvex. First glume not fused with the callus; absent. Rachilla not pronounced below the second glume; not pronounced between the florets. Second glume present, or absent; rounded on the back. Fertile florets 1. Lemma of lower floret membranous; consistent in texture; lacking a central longitudinal groove.

Lemma of upper floret chartaceous; minutely muricate; brown; dull; with flat margins; with margins thinner in texture than the body; glabrous; without basal modifications; not differentiated at the apex. C-4. Africa.

Brachiaria (Trin.) Griseb.—see WEBSTER (1988).

Calyptochloa C.E. Hubb.

Plants hermaphroditic; perennial. Flowering culms terminated by a solitary inflorescence. Ligule a fringe of hairs. Inflorescence a raceme. Main axis with quaquaversal primary branches. Rachis terminating in a spikelet. Pedicels truncate at the apex to cupuliform at the apex; perpendicular with the spikelet base; concave. Disarticulation at the spikelet base and at the culm nodes. Callus not differentiated. Cleistogamous inflorescence present. Cleistogamous spikelets morphologically different from the chasmogamous spikelets. Spikelets solitary; homomorphic; adaxial; dorsiventrally compressed. First glume not fused with the callus; present; not encircling the spikelet base; not inflated at the base. Rachilla not pronounced below the second glume; pronounced between the florets; lacking lateral appendages. Second glume present; rounded on the back; indumentum not uncinate. Fertile florets 1. Lemma of lower floret membranous; consistent in texture; lacking a central longitudinal groove. Lemma of upper floret cartilaginous; smooth; brown to yellow; dull; with flat margins to with involute margins; with margins thinner in texture than the body to with margins of the same texture as the body; glabrous; without basal modifications; not differentiated at the apex. C-3. Base chromosome number, x = 9, or 12. Australia.

Cenchrus L.—see WEBSTER (1988).

Chaetopoa C.E. Hubb.

Plants hermaphroditic; annual. Flowering culms terminated by a solitary inflorescence. Ligule a membrane. Inflorescence a panicle. Main axis with quaquaversal primary branches. Primary branches appressed to the main axis; with appressed secondary branches. Rachis terminating in a spikelet. Disarticulation at the base of the primary branches. Callus differentiated. Cleistogamous inflorescence absent. Spikelets in clusters of 4 or more; homomorphic; abaxial; dorsiventrally compressed. First glume not fused with the callus; present (bristle-like); not encircling the spikelet base; not inflated at the base. Rachilla not pronounced below the second glume; not pronounced between the florets. Second glume present; rounded on the back. Fertile florets 1. Lemma of lower floret hyaline; consistent in texture; lacking a central longitudinal groove. Lemma of upper floret hyaline; smooth; white; dull; with flat margins; with margins thinner in texture than the body; glabrous; without basal modifications; not differentiated at the apex. C-4. Africa.

Chamaeraphis R. Br.

Plants hermaphroditic; perennial. Flowering culms terminated by a solitary inflorescence. Ligule a membrane. Inflorescence a panicle. Main axis with distichous primary branches. Primary branches appressed to the main axis; with appressed secondary branches. Rachis terminating in a bristle. Bristles unbranched. Pedicels perpendicular with the spikelet base. Disarticulation at the base of the primary branches. Callus differentiated. Cleistogamous inflorescence absent. Spikelets solitary; homomorphic; abaxial; planoconvex to terete. First glume not fused with the callus; present; not encircling the spikelet base; not inflated at the base. Rachilla not pronounced below the second glume; not pronounced between the florets. Second glume present; rounded on the back. Fertile florets 1. Lemma of lower floret chartaceous to cartilaginous; consistent in texture; lacking a central longitudinal groove. Lemma of upper floret membranous; smooth; white; dull; with flat margins; with margins thinner in texture than the body; glabrous; without basal modifications; not differentiated at the apex. C-4. Australia.

Chlorocalymma Clayton

Plants hermaphroditic; annual. Flowering culms terminated by a solitary inflorescence. Ligule a membrane. Inflorescence a panicle. Primary branches reduced to a fascicle of spikelets. Rachis terminating in a bristle. Bristles branched. Pedicels perpendicular with the spikelet base. Disarticulation at the base of the primary branches. Callus differentiated. Cleistogamous inflorescence absent. Spikelets solitary; homomorphic; adaxial; dorsiventrally compressed. First glume not fused with the callus; present; not encircling the spikelet base; not inflated at the base. Rachilla not pronounced below the second glume; not pronounced between the florets. Second glume present; rounded on the back. Fertile florets 1. Lemma of lower floret membranous; consistent in texture; lacking a central longitudinal groove. Lemma of upper floret chartaceous; smooth; yellow; dull; with flat margins; with margins thinner in texture than the body; glabrous; without basal modifications; not differentiated at the apex. C-4. Africa.

Cleistochloa C.E. Hubb.

Plants hermaphroditic; perennial. Flowering culms terminated by a solitary inflorescence. Ligule a fringe of hairs. Inflorescence a panicle, or a raceme. Main axis with distichous primary branches, or with quaquaversal primary branches. Primary branches appressed to the main axis; with appressed secondary branches. Rachis terminating in a spikelet. Pedicels cupuliform at the apex; perpendicular with the spikelet base; concave. Disarticulation at the spikelet base. Callus not differentiated. Cleistogamous inflorescence present. Cleistogamous spikelets morphologically different from the chasmogamous spikelets. Spikelets solitary;

homomorphic; adaxial; dorsiventrally compressed. First glume not fused with the callus; present, or absent; not encircling the spikelet base; not inflated at the base. Rachilla not pronounced below the second glume; not pronounced between the florets. Second glume present; rounded on the back; indumentum not uncinate. Fertile florets 1. Lemma of lower floret membranous; consistent in texture; lacking a central longitudinal groove. Lemma of upper floret cartilaginous to indurate; muricate; brown to yellow; dull; with flat margins; with margins thinner in texture than the body; glabrous to hairy; without basal modifications; differentiated at the apex, or not differentiated at the apex. C-3. Australia.

Coelachne R. Br.

Plants hermaphroditic; annual, or perennial. Flowering culms terminated by a solitary inflorescence. Ligule a fringe of hairs, or absent. Inflorescence a panicle. Main axis with quaquaversal primary branches. Primary branches spreading to reflexed; with appressed secondary branches to with spreading secondary branches. Rachis terminating in a spikelet. Pedicels perpendicular with the spikelet base. Disarticulation above the lower glume; at the base of the lowest floret. Callus not differentiated. Cleistogamous inflorescence absent. Spikelets solitary, or paired; homomorphic; abaxial; dorsiventrally compressed. First glume not fused with the callus; present; not encircling the spikelet base; not inflated at the base. Rachilla pronounced below the second glume; pronounced between the florets; lacking lateral appendages. Second glume present; rounded on the back. Fertile florets 2. Lemma of lower floret membranous; consistent in texture; lacking a central longitudinal groove. Lemma of upper floret membranous; smooth; green, or purple; dull; with flat margins; with margins of the same texture as the body; glabrous, or hairy; without basal modifications; not differentiated at the apex. C-3. Base chromosome number, x = 10. Africa, or Asia, or Australia.

Cyphochlaena Hack.

Plants hermaphroditic; annual. Flowering culms terminated by a solitary inflorescence. Ligule a ciliate membrane. Inflorescence a panicle. Main axis with secund primary branches. Primary branches appressed to the main axis to spreading; with appressed secondary branches. Rachis terminating in a spikelet. Pedicels perpendicular with the spikelet base; flat. Disarticulation at the spikelet base. Callus not differentiated. Cleistogamous inflorescence absent. Spikelets paired; heteromorphic; adaxial (but difficult to determine); laterally compressed. First glume not fused with the callus; present; not encircling the spikelet base; not inflated at the base. Rachilla not pronounced below the second glume; not pronounced between the florets. Second glume present; rounded on the back. Fertile florets 1. Lemma of lower floret cartilaginous; consistent in texture; lacking a central longitudinal groove. Lemma of upper floret hyaline; smooth;

white; dull; with flat margins; with margins of the same texture as the body; glabrous; without basal modifications; not differentiated at the apex. C-3. Africa.

Cyrtococcum Stapf

Plants hermaphroditic; annual, or perennial. Flowering culms terminated by a solitary inflorescence. Ligule a membrane. Inflorescence a panicle. Main axis with quaquaversal primary branches. Primary branches appressed to the main axis to spreading; with appressed secondary branches, or with spreading secondary branches. Rachis terminating in a spikelet. Pedicels truncate at the apex, or cupuliform at the apex; perpendicular with the spikelet base; concave. Disarticulation at the spikelet base. Callus differentiated to not differentiated. Cleistogamous inflorescence absent. Spikelets solitary; homomorphic; adaxial; laterally compressed. First glume not fused with the callus; present; encircling the spikelet base to not encircling the spikelet base; not inflated at the base. Rachilla pronounced below the second glume, or not pronounced below the second glume; not pronounced between the florets. Second glume present; rounded on the back; indumentum not uncinate. Fertile florets 1. Lemma of lower floret membranous; consistent in texture; lacking a central longitudinal groove. Lemma of upper floret chartaceous to cartilaginous; smooth to striate; white, or yellow; dull; with involute margins; with margins of the same texture as the body; glabrous; constricted at the base to without basal modifications; differentiated at the apex. C-3. Africa, Asia, Australia, and Pacific Islands.

Digitaria Haller—see WEBSTER (1988).

Dissochondrus (Hillebr.) Kuntze

Plants hermaphroditic; perennial. Flowering culms terminated by a solitary inflorescence. Ligule a ciliate membrane. Inflorescence a panicle. Main axis with quaquaversal primary branches. Primary branches appressed to the main axis; with appressed secondary branches. Rachis terminating in a bristle. Bristles unbranched. Pedicels discoid at the apex; perpendicular with the spikelet base; concave. Disarticulation at the spikelet base. Callus not differentiated. Cleistogamous inflorescence present. Cleistogamous spikelets similar to the chasmogamous spikelets. Spikelets solitary; homomorphic; abaxial; dorsiventrally compressed. First glume not fused with the callus; present; encircling the spikelet base; not inflated at the base. Rachilla not pronounced below the second glume; not pronounced between the florets. Second glume present; rounded on the back. Fertile florets 1-3. Lemma of lower floret cartilaginous; consistent in texture; lacking a central longitudinal groove. Lemma of upper floret cartilaginous; smooth (minutely transverse rugose); brown to yellow; shiny; with involute margins; with margins of the same texture as the body; glabrous; without basal modifications; not differentiated at the apex. C-4. Pacific Islands.

Eccoptocarpha Launert

Plants hermaphroditic; annual. Flowering culms terminated by a solitary inflorescence. Ligule a fringe of hairs. Inflorescence a panicle. Main axis with secund primary branches. Primary branches spreading; with appressed secondary branches. Rachis terminating in a spikelet. Pedicels discoid at the apex; perpendicular with the spikelet base; concave. Disarticulation at the spikelet base (occ. at the base of the upper floret). Callus not differentiated. Cleistogamous inflorescence absent. Spikelets solitary; homomorphic; adaxial; dorsiventrally compressed. First glume not fused with the callus; present; encircling the spikelet base; not inflated at the base. Rachilla not pronounced below the second glume; pronounced between the florets; lacking lateral appendages. Second glume present; slightly saccate; indumentum not uncinate. Fertile florets 1. Lemma of lower floret membranous; consistent in texture; lacking a central longitudinal groove. Lemma of upper floret cartilaginous; smooth; yellow; shiny; with involute margins; with margins of the same texture as the body; glabrous; without basal modifications; not differentiated at the apex. C-4. Africa.

Echinochloa P. Beauv.—see WEBSTER (1988).

Echinolaena Desv.—see WEBSTER & VALDEZ R. (1988).

Entolasia Stapf

Plants hermaphroditic; perennial. Flowering culms terminated by a solitary inflorescence. Ligule a fringe of hairs. Inflorescence a panicle, or a raceme. Main axis with quaquaversal primary branches. Primary branches appressed to the main axis, or spreading; with appressed secondary branches. Rachis terminating in a spikelet. Pedicels cupuliform at the apex; perpendicular with the spikelet base; concave. Disarticulation at the spikelet base. Callus not differentiated. Cleistogamous inflorescence absent. Spikelets solitary; homomorphic; adaxial; dorsiventrally compressed. First glume not fused with the callus; present; encircling the spikelet base, or not encircling the spikelet base; inflated at the base, or not inflated at the base. Rachilla not pronounced below the second glume; not pronounced between the florets. Second glume present; rounded on the back. Fertile florets 1. Lemma of lower floret membranous; consistent in texture; lacking a central longitudinal groove. Lemma of upper floret cartilaginous; smooth to striate; white to yellow; dull; with involute margins; with margins of the same texture as the body; hairy; constricted at the base, or without basal modifications; not differentiated at the apex. C-3. Base chromosome number, x = 9. Africa and Australia.

Eriochloa Kunth—see WEBSTER (1988).

Heteranthoecia Stapf

Plants hermaphroditic; annual. Flowering culms terminated by a solitary inflorescence. Ligule a fringe of hairs. Inflorescence a panicle. Main axis with quaquaversal primary branches. Primary branches reflexed; with appressed secondary branches. Rachis terminating in a spikelet. Pedicels perpendicular with the spikelet base. Disarticulation above the lower glume; at the base of the lowest floret. Callus not differentiated. Cleistogamous inflorescence absent. Spikelets solitary; homomorphic; abaxial; dorsiventrally compressed. First glume not fused with the callus; present; not encircling the spikelet base; not inflated at the base. Rachilla pronounced below the second glume; pronounced between the florets; lacking lateral appendages. Second glume present; rounded on the back. Fertile florets 2. Lemma of lower floret chartaceous; consistent in texture; lacking a central longitudinal groove. Lemma of upper floret chartaceous; smooth; white; dull; with flat margins; with margins of the same texture as the body; hairy; without basal modifications; not differentiated at the apex. C-3. Base chromosome number, x = 10. Africa.

Holcolemma Stapf & C.E. Hubb.

Plants hermaphroditic; annual, or perennial. Flowering culms terminated by a solitary inflorescence. Ligule a membrane. Inflorescence a panicle. Main axis with quaquaversal primary branches. Primary branches appressed to the main axis; with appressed secondary branches, or reduced to a fascicle of spikelets. Rachis terminating in a spikelet, or terminating in a bristle. Bristles unbranched. Pedicels discoid at the apex; perpendicular with the spikelet base; concave. Disarticulation at the spikelet base. Callus not differentiated (with a minute stipe). Cleistogamous inflorescence absent. Spikelets solitary; homomorphic; dorsiventrally compressed. First glume not fused with the callus; present; not encircling the spikelet base; inflated at the base. Rachilla not pronounced below the second glume; not pronounced between the florets. Second glume present; rounded on the back. Fertile florets 1. Lemma of lower floret membranous; with the area between the central nerve and the first lateral nerve thinner in texture than the rest of the structure; with a central longitudinal groove. Lemma of upper floret cartilaginous; rugose; yellow; dull; with involute margins; with margins of the same texture as the body; glabrous; without basal modifications; not differentiated at the apex. Africa.

Homopholis C.E. Hubb.

Plants hermaphroditic; perennial. Flowering culms terminated by a solitary inflorescence. Ligule a membrane. Inflorescence a panicle. Primary branches spreading; with appressed secondary branches, or with spreading secondary branches. Rachis terminating in a spikelet. Pedicels cupuliform at the apex; perpendicular with the spikelet base; concave. Disarticulation at the spikelet

base. Callus not differentiated. Cleistogamous inflorescence absent. Spikelets solitary; homomorphic; abaxial; laterally compressed to dorsiventrally compressed. First glume not fused with the callus; present; encircling the spikelet base; not inflated at the base. Rachilla pronounced below the second glume; not pronounced between the florets. Second glume present; rounded on the back; indumentum not uncinate. Fertile florets 1. Lemma of lower floret membranous to chartaceous; consistent in texture; lacking a central longitudinal groove. Lemma of upper floret cartilaginous to indurate; smooth, or striate; yellow; shiny; with flat margins; with margins of the same texture as the body; glabrous; without basal modifications; not differentiated at the apex. C-3. Australia.

Hydrothauma C.E. Hubb.

Plants hermaphroditic; annual. Flowering culms terminated by a solitary inflorescence. Ligule a membrane. Inflorescence a panicle. Main axis with quaquaversal primary branches. Primary branches appressed to the main axis; with appressed secondary branches. Rachis terminating in a spikelet. Pedicels discoid at the apex; perpendicular with the spikelet base; concave. Disarticulation at the spikelet base. Callus not differentiated. Cleistogamous inflorescence absent. Spikelets solitary; homomorphic; abaxial; dorsiventrally compressed to planoconvex. First glume not fused with the callus; present; encircling the spikelet base; not inflated at the base. Rachilla not pronounced below the second glume; not pronounced between the florets. Second glume present; slightly gibbose, or rounded on the back. Fertile florets 1. Lemma of lower floret membranous; consistent in texture; lacking a central longitudinal groove. Lemma of upper floret chartaceous; smooth; brown; shiny; with involute margins; with margins of the same texture as the body; glabrous; without basal modifications; not differentiated at the apex. C-3. Africa.

Hygrochloa Lazarides

Plants monoecious; annual, or perennial. Flowering culms terminated by a solitary inflorescence. Ligule a fringe of hairs. Inflorescence a panicle. Main axis with secund primary branches. Primary branches appressed to the main axis; with appressed secondary branches. Rachis terminating in an unmodified naked point. Bristles unbranched. Pedicels discoid at the apex; perpendicular with the spikelet base; concave. Disarticulation at the spikelet base. Callus not differentiated. Cleistogamous inflorescence absent. Spikelets solitary; heteromorphic; abaxial; planoconvex. First glume not fused with the callus; present; not encircling the spikelet base; not inflated at the base. Rachilla not pronounced below the second glume; not pronounced between the florets. Second glume present; rounded on the back. Fertile florets 1. Lemma of lower floret membranous; with a hyaline area at the base, or consistent in texture; lacking a central longitudinal groove. Lemma of upper floret chartaceous to cartilaginous; striate; white, or brown, or yellow;

dull; with flat margins; with margins thinner in texture than the body; glabrous; without basal modifications; not differentiated at the apex. C-4. Australia.

Hylebates L. Chippindall

Plants hermaphroditic; annual. Flowering culms terminated by a solitary inflorescence. Ligule a ciliate membrane. Inflorescence a panicle. Main axis with quaquaversal primary branches. Primary branches spreading; with spreading secondary branches. Rachis terminating in a spikelet. Pedicels cupuliform at the apex; perpendicular with the spikelet base; concave. Disarticulation above the lower glume, or at the spikelet base; at the base of the floret. Callus not differentiated. Cleistogamous inflorescence absent. Spikelets solitary; homomorphic; adaxial; dorsiventrally compressed. First glume not fused with the callus; present; not encircling the spikelet base; not inflated at the base. Rachilla pronounced below the second glume; pronounced between the florets to not pronounced between the florets; lacking lateral appendages. Second glume present; rounded on the back. Fertile florets 1. Lemma of lower floret membranous; consistent in texture; lacking a central longitudinal groove. Lemma of upper floret membranous to chartaceous; smooth; grey, or yellow; dull; with flat margins; with margins thinner in texture than the body; glabrous; without basal modifications; not differentiated at the apex. C-4. Africa.

Hymenachne P. Beauv.—see WEBSTER (1988).

Ichnanthus P. Beauv.—see WEBSTER & VALDEZ R. (1988).

Isachne R. Br.—see WEBSTER & VALDEZ R. (1988).

Lecomtella A. Camus

Plants andromonoecious; perennial. Flowering culms terminated by a solitary inflorescence. Ligule a fringe of hairs. Inflorescence a panicle. Main axis with quaquaversal primary branches. Primary branches appressed to the main axis; with appressed secondary branches. Rachis terminating in a spikelet. Pedicels truncate at the apex; perpendicular with the spikelet base; concave. Disarticulation at the spikelet base. Callus not differentiated. Cleistogamous inflorescence absent. Spikelets solitary; homomorphic; adaxial; laterally compressed. First glume not fused with the callus; present; not encircling the spikelet base; not inflated at the base. Rachilla pronounced below the second glume; not pronounced between the florets. Second glume present; rounded on the back. Fertile florets 1. Lemma of lower floret membranous to chartaceous; consistent in texture; lacking a central longitudinal groove. Lemma of upper floret membranous to chartaceous; smooth; yellow to green; dull; with flat margins; with margins thinner in texture than the body; glabrous; without basal modifications; not differentiated at the apex. C-3. Africa.

Limnopoa C.E. Hubb.

Plants hermaphroditic; annual. Flowering culms terminated by a solitary inflorescence. Ligule a fringe of hairs. Inflorescence a raceme. Main axis with distichous primary branches. Rachis terminating in a spikelet. Pedicels perpendicular with the spikelet base. Disarticulation above the lower glume; between the glumes, or at the base of the lowest floret. Callus not differentiated. Cleistogamous inflorescence absent. Spikelets paired; homomorphic; abaxial; dorsiventrally compressed. First glume not fused with the callus; present; not encircling the spikelet base; not inflated at the base. Rachilla not pronounced below the second glume; pronounced between the florets; lacking lateral appendages. Second glume present; rounded on the back. Fertile florets 1. Lemma of lower floret membranous; consistent in texture; lacking a central longitudinal groove. Lemma of upper floret cartilaginous; smooth; white; dull; with involute margins; with margins of the same texture as the body; hairy; without basal modifications; not differentiated at the apex. C-3. Asia.

Louisiella C.E. Hubb. & Leonard

Plants hermaphroditic; perennial. Flowering culms terminated by a solitary inflorescence. Ligule a ciliate membrane. Inflorescence a panicle. Main axis with quaquaversal primary branches. Primary branches spreading; with appressed secondary branches. Rachis terminating in a spikelet. Pedicels truncate at the apex; perpendicular with the spikelet base; shallow concave. Disarticulation at the spikelet base. Callus not differentiated. Cleistogamous inflorescence absent. Spikelets solitary, or paired; homomorphic; adaxial; dorsiventrally compressed. First glume not fused with the callus; present; not encircling the spikelet base; not inflated at the base. Rachilla not pronounced below the second glume; not pronounced between the florets. Second glume present; rounded on the back. Fertile florets 1. Lemma of lower floret membranous; consistent in texture; lacking a central longitudinal groove. Lemma of upper floret chartaceous; smooth; yellow; dull; with involute margins; with margins of the same texture as the body; glabrous; without basal modifications; not differentiated at the apex. C-4. Africa.

Megaloprotachne C.E. Hubb.

Plants hermaphroditic; annual. Flowering culms terminated by a solitary inflorescence. Ligule a membrane, or a ciliate membrane. Inflorescence a panicle. Main axis with quaquaversal primary branches. Primary branches appressed to the main axis to spreading; with appressed secondary branches. Rachis terminating in a spikelet. Pedicels cupuliform at the apex; perpendicular with the spikelet base; concave. Disarticulation at the spikelet base. Callus not differentiated. Cleistogamous inflorescence absent. Spikelets solitary, or paired; homomorphic;

abaxial; planoconvex. First glume not fused with the callus; present; not encircling the spikelet base; not inflated at the base. Rachilla not pronounced below the second glume (or minutely developed); not pronounced between the florets. Second glume present; rounded on the back; indumentum not uncinate. Fertile florets 1. Lemma of lower floret hyaline to membranous; with the area between the central nerve and the first lateral nerve thinner in texture than the rest of the structure; lacking a central longitudinal groove. Lemma of upper floret chartaceous to cartilaginous; striate to muricate; brown; dull; with flat margins; with margins thinner in texture than the body; glabrous; without basal modifications; not differentiated at the apex. C-4. Africa.

Melinis P. Beauv.—see WEBSTER (1988).

Microcalamus Franch.

Plants hermaphroditic; perennial. Flowering culms terminated by a solitary inflorescence. Ligule a ciliate membrane. Inflorescence a panicle. Main axis with quaquaversal primary branches. Primary branches appressed to the main axis to spreading; with appressed secondary branches to with spreading secondary branches. Rachis terminating in a spikelet. Pedicels cupuliform at the apex (but difficult to determine); perpendicular with the spikelet base; concave (but shallow). Disarticulation at the spikelet base. Callus not differentiated. Cleistogamous inflorescence absent. Spikelets solitary, or paired; homomorphic; adaxial; dorsiventrally compressed. First glume not fused with the callus; present; encircling the spikelet base; not inflated at the base. Rachilla pronounced below the second glume; pronounced between the florets; lacking lateral appendages. Second glume present; rounded on the back. Fertile florets 1. Lemma of lower floret membranous to chartaceous; consistent in texture; lacking a central longitudinal groove. Lemma of upper floret indurate; smooth (or minutely muricate); yellow; dull; with flat margins; with margins of the same texture as the body; glabrous, or hairy (especially on the margins); without basal modifications; differentiated at the apex. C-3. Africa.

Mildbraediochloa Butzin

Plants hermaphroditic; perennial. Flowering culms terminated by a solitary inflorescence. Ligule a fringe of hairs. Inflorescence a panicle. Main axis with quaquaversal primary branches. Primary branches spreading; with appressed secondary branches to with spreading secondary branches. Rachis terminating in a spikelet. Pedicels cupuliform at the apex; perpendicular with the spikelet base; concave. Disarticulation at the spikelet base. Callus not differentiated. Cleistogamous inflorescence absent. Spikelets solitary; homomorphic; adaxial, or with lateral orientation; laterally compressed. First glume not fused with the callus; present; encircling the spikelet base; not inflated at the base. Rachilla not pro-

nounced below the second glume; not pronounced between the florets. Second glume present; rounded on the back; indumentum not uncinate. Fertile florets 1. Lemma of lower floret membranous; consistent in texture; lacking a central longitudinal groove. Lemma of upper floret hyaline; smooth; dull; with flat margins; with margins of the same texture as the body; glabrous; without basal modifications; not differentiated at the apex. Africa.

Neurachne R. Br.

Plants hermaphroditic; perennial. Flowering culms terminated by a solitary inflorescence. Ligule a fringe of hairs. Inflorescence a raceme. Main axis with quaquaversal primary branches. Rachis terminating in a spikelet. Pedicels cupuliform at the apex; perpendicular with the spikelet base, or oblique to the spikelet base; concave. Disarticulation at the spikelet base. Callus differentiated. Cleistogamous inflorescence absent. Spikelets solitary; homomorphic; abaxial; laterally compressed, or dorsiventrally compressed. First glume not fused with the callus; present; not encircling the spikelet base; not inflated at the base. Rachilla not pronounced below the second glume; not pronounced between the florets. Second glume present; rounded on the back; indumentum not uncinate. Fertile florets 1. Lemma of lower floret hyaline to chartaceous; consistent in texture; lacking a central longitudinal groove. Lemma of upper floret hyaline to membranous; smooth; white; dull; with flat margins; with margins of the same texture as the body; glabrous; without basal modifications; not differentiated at the apex. C-4, or C-3. Base chromosome number, x = 9. Australia.

Odontelytrum Hack.

Plants hermaphroditic; perennial. Flowering culms terminated by a solitary inflorescence. Ligule a membrane. Inflorescence a panicle. Main axis with quaquaversal primary branches. Primary branches appressed to the main axis; reduced to a fascicle of spikelets. Rachis terminating in a bristle. Bristles branched. Pedicels perpendicular with the spikelet base. Disarticulation at the base of the primary branches. Callus not differentiated. Cleistogamous inflorescence absent. Spikelets solitary; homomorphic; adaxial; dorsiventrally compressed. First glume not fused with the callus; present, or absent (usually present); not encircling the spikelet base; not inflated at the base. Rachilla not pronounced below the second glume; not pronounced between the florets. Second glume present; rounded on the back. Fertile florets 1. Lemma of lower floret membranous; consistent in texture; lacking a central longitudinal groove. Lemma of upper floret chartaceous; smooth; black; dull; with flat margins; with margins thinner in texture than the body to with margins of the same texture as the body; glabrous; without basal modifications; differentiated at the apex. C-4. Africa.

Oplismenus P. Beauv.—see WEBSTER (1988).

Oryzidium C.E. Hubb. & Schweick.

Plants hermaphroditic; perennial. Flowering culms terminated by a solitary inflorescence. Ligule a fringe of hairs. Inflorescence a panicle. Main axis with quaquaversal primary branches. Primary branches spreading; with appressed secondary branches to with spreading secondary branches. Rachis terminating in a spikelet. Pedicels cupuliform at the apex; perpendicular with the spikelet base; concave. Disarticulation at the spikelet base. Callus not differentiated. Cleistogamous inflorescence absent. Spikelets solitary; homomorphic; adaxial; dorsiventrally compressed. First glume not fused with the callus; present; encircling the spikelet base; not inflated at the base. Rachilla pronounced below the second glume; pronounced between the florets; lacking lateral appendages. Second glume present; rounded on the back. Fertile florets 1. Lemma of lower floret hyaline to membranous; consistent in texture; lacking a central longitudinal groove. Lemma of upper floret chartaceous; smooth; yellow; shiny; with involute margins; with margins of the same texture as the body; glabrous; without basal modifications; not differentiated at the apex. C-4. Africa.

Ottochloa Dandy

Plants hermaphroditic; annual, or perennial. Flowering culms terminated by a solitary inflorescence. Ligule a ciliate membrane. Inflorescence a panicle. Main axis with quaquaversal primary branches. Primary branches spreading; with appressed secondary branches, or with spreading secondary branches. Rachis terminating in a spikelet. Pedicels cupuliform at the apex; perpendicular with the spikelet base; concave. Disarticulation at the spikelet base. Callus not differentiated. Cleistogamous inflorescence absent. Spikelets solitary; homomorphic; abaxial; dorsiventrally compressed to planoconvex. First glume not fused with the callus; present; not encircling the spikelet base; not inflated at the base. Rachilla not pronounced below the second glume; not pronounced between the florets. Second glume present; rounded on the back. Fertile florets 1. Lemma of lower floret membranous; consistent in texture; lacking a central longitudinal groove. Lemma of upper floret cartilaginous to indurate; muricate; yellow; dull; with involute margins; with margins of the same texture as the body; glabrous; with basal scars or appendages, or constricted at the base, or without basal modifications; not differentiated at the apex. C-3. Africa, or Asia, or Australia.

Panicum L.—see WEBSTER (1988).

Paractaenum P. Beauv.

Plants hermaphroditic; annual. Flowering culms terminated by a solitary inflorescence. Ligule a membrane, or a fringe of hairs. Inflorescence a panicle. Main axis with distichous primary branches. Primary branches reflexed; with

appressed secondary branches. Rachis terminating in a spikelet, or terminating in an unmodified naked point. Bristles unbranched or branched. Pedicels truncate at the apex; perpendicular with the spikelet base. Disarticulation at the base of the primary branches. Callus differentiated. Cleistogamous inflorescence absent. Spikelets solitary; homomorphic; abaxial; dorsiventrally compressed, or planoconvex. First glume not fused with the callus; present; encircling the spikelet base; not inflated at the base. Rachilla not pronounced below the second glume; not pronounced between the florets. Second glume present; rounded on the back. Fertile florets 1. Lemma of lower floret membranous; consistent in texture; lacking a central longitudinal groove. Lemma of upper floret cartilaginous; muricate, or rugose; brown to yellow; dull; with involute margins; with margins of the same texture as the body; glabrous; constricted at the base, or without basal modifications; not differentiated at the apex. C-4. Australia.

Paraneurachne S.T. Blake

Plants hermaphroditic; perennial. Flowering culms terminated by a solitary inflorescence. Ligule a fringe of hairs. Inflorescence a raceme. Rachis terminating in a spikelet. Pedicels discoid at the apex; oblique to the spikelet base; concave. Disarticulation at the spikelet base. Callus differentiated. Cleistogamous inflorescence absent. Spikelets solitary; homomorphic; abaxial; planoconvex. First glume not fused with the callus; present; encircling the spikelet base; not inflated at the base. Rachilla not pronounced below the second glume; not pronounced between the florets. Second glume present; rounded on the back; indumentum not uncinate. Fertile florets 1. Lemma of lower floret chartaceous; consistent in texture; lacking a central longitudinal groove. Lemma of upper floret indurate; muricate and rugose; yellow; with involute margins; with margins of the same texture as the body; glabrous; without basal modifications; not differentiated at the apex. Base chromosome number, x = 9. Australia.

Paratheria Griseb.—see WEBSTER & VALDEZ R. (1988).

Paspalidium Stapf—see Webster (1988).

Paspalum L.—see WEBSTER (1988).

Pennisetum Rich.—see WEBSTER (1988).

Poecilostachys Hack.

Plants hermaphroditic; perennial. Flowering culms terminated by a solitary inflorescence. Ligule a membrane. Inflorescence a panicle. Main axis with secund primary branches. Primary branches spreading; with appressed secondary branches. Rachis terminating in a spikelet. Pedicels cupuliform at the apex; perpendicular with the spikelet base; concave. Disarticulation at the spikelet base. Callus not

differentiated. Cleistogamous inflorescence absent. Spikelets solitary, or paired; homomorphic; adaxial; laterally compressed. First glume not fused with the callus; present; encircling the spikelet base; not inflated at the base. Rachilla pronounced below the second glume, or not pronounced below the second glume; pronounced between the florets, or not pronounced between the florets; lacking lateral appendages. Second glume present; rounded on the back; indumentum not uncinate. Fertile florets 1. Lemma of lower floret membranous; consistent in texture; lacking a central longitudinal groove. Lemma of upper floret membranous to chartaceous; smooth; yellow; shiny; with involute margins; with margins of the same texture as the body; glabrous; without basal modifications; not differentiated at the apex. C-3. Africa.

Pseudechinolaena Stapf—see WEBSTER & VALDEZ R. (1988).

Pseudochaetochloa Hitchc.

Plants andromonoecious; perennial. Flowering culms terminated by a solitary inflorescence. Ligule a fringe of hairs. Inflorescence a panicle. Main axis with quaquaversal primary branches. Primary branches reflexed; with appressed secondary branches and reduced to a fascicle of spikelets. Rachis terminating in a bristle. Bristles unbranched. Pedicels discoid at the apex; perpendicular with the spikelet base; concave. Disarticulation at the spikelet base and at the base of the primary branches. Callus differentiated, or not differentiated. Cleistogamous inflorescence absent. Spikelets solitary; homomorphic; abaxial; laterally compressed, or dorsiventrally compressed. First glume not fused with the callus; present; not encircling the spikelet base; not inflated at the base. Rachilla not pronounced below the second glume; not pronounced between the florets. Second glume present; rounded on the back. Lemma of lower floret membranous to chartaceous; consistent in texture; lacking a central longitudinal groove. Lemma of upper floret membranous to chartaceous; smooth; white; with flat margins; with margins thinner in texture than the body; glabrous; without basal modifications; not differentiated at the apex. Australia.

Pseudoraphis Griff.

Plants hermaphroditic; perennial. Flowering culms terminated by a solitary inflorescence. Ligule a membrane, or a fringe of hairs. Inflorescence a panicle, or a raceme. Main axis with quaquaversal primary branches. Primary branches appressed to the main axis, or spreading; with appressed secondary branches. Rachis terminating in an unmodified naked point. Bristles unbranched. Pedicels truncate at the apex, or discoid at the apex; perpendicular with the spikelet base; flat. Disarticulation at the spikelet base, or at the base of the primary branches. Callus not differentiated. Cleistogamous inflorescence absent. Spikelets solitary; homomorphic; abaxial; planoconvex to terete. First glume not fused with the

callus; present; not encircling the spikelet base; not inflated at the base. Rachilla not pronounced below the second glume; pronounced between the florets; lacking lateral appendages. Second glume present; rounded on the back. Fertile florets 1. Lemma of lower floret hyaline to chartaceous; consistent in texture; lacking a central longitudinal groove. Lemma of upper floret hyaline to membranous; smooth; white; shiny; with flat margins; with margins of the same texture as the body; glabrous; without basal modifications; not differentiated at the apex. C-4. Base chromosome number, x = 8. Asia, Australia, and Pacific Islands.

Rhynchelytrum Nees—see WEBSTER (1988).

Sacciolepis Nash—see WEBSTER (1988).

Setaria P. Beauv.—see WEBSTER (1988).

Snowdenia C.E. Hubb.

Plants hermaphroditic; annual. Flowering culms terminated by a solitary inflorescence. Ligule a membrane, or a ciliate membrane. Inflorescence a raceme. Main axis with quaquaversal primary branches. Primary branches appressed to the main axis. Rachis terminating in a spikelet. Pedicels perpendicular with the spikelet base; convex. Disarticulation at the spikelet base. Callus not differentiated. Cleistogamous inflorescence absent. Spikelets solitary; homomorphic; abaxial; dorsiventrally compressed to planoconvex. First glume not fused with the callus; present; not encircling the spikelet base; not inflated at the base. Rachilla not pronounced below the second glume; not pronounced between the florets. Second glume present; rounded on the back. Fertile florets 1. Lemma of lower floret membranous; consistent in texture; lacking a central longitudinal groove. Lemma of upper floret membranous; scabrous; green; dull; with flat margins; with margins thinner in texture than the body; glabrous; without basal modifications; not differentiated at the apex. C-4. Africa.

Sphaerocaryum Hook. f.

Plants hermaphroditic; annual. Flowering culms terminated by a solitary inflorescence. Ligule a fringe of hairs. Inflorescence a panicle. Main axis with quaquaversal primary branches. Primary branches spreading; with spreading secondary branches. Rachis terminating in a spikelet. Disarticulation above the lower glume; at the base of the lowest floret. Callus not differentiated. Cleistogamous inflorescence absent. Spikelets solitary; homomorphic; abaxial; dorsiventrally compressed. First glume not fused with the callus; present; not encircling the spikelet base; not inflated at the base. Rachilla pronounced below the second glume. Second glume present; rounded on the back; indumentum not uncinate. Fertile florets 1. Lemma of lower floret consistent in texture; lacking a central longitudinal groove. Lemma of upper floret membranous; smooth;

purple; dull; with flat margins; with margins of the same texture as the body; hairy; without basal modifications; not differentiated at the apex. C-3. Base chromosome number, x = 10. Asia.

Spinifex L.

Plants dioecious; perennial. Flowering culms with inflorescences densely clustered in a spatheate panicle. Ligule a fringe of hairs. Inflorescence a raceme, or a spike. Rachis terminating in a bristle. Bristles unbranched. Pedicels cupuliform at the apex; perpendicular with the spikelet base; concave. Disarticulation at the base of the inflorescence and at the culm nodes. Callus differentiated. Cleistogamous inflorescence absent. Spikelets solitary; homomorphic; abaxial; dorsiventrally compressed. First glume not fused with the callus; present; not encircling the spikelet base; not inflated at the base. Rachilla not pronounced below the second glume; not pronounced between the florets. Second glume present; rounded on the back; indumentum not uncinate. Fertile florets 1. Lemma of lower floret chartaceous to cartilaginous; consistent in texture; lacking a central longitudinal groove. Lemma of upper floret cartilaginous, or indurate; smooth; yellow; dull; with flat margins; with margins thinner in texture than the body; glabrous; without basal modifications; not differentiated at the apex. C-4. Base chromosome number, x = 9. Asia and Australia.

Stenotaphrum Trin.—see WEBSTER (1988).

Stereochlaena Hack.

Plants hermaphroditic; annual, or perennial. Flowering culms terminated by a solitary inflorescence. Ligule a ciliate membrane. Inflorescence a panicle. Primary branches spreading; with appressed secondary branches. Rachis terminating in a spikelet. Pedicels truncate at the apex; perpendicular with the spikelet base; concave. Disarticulation at the spikelet base. Callus not differentiated. Cleistogamous inflorescence absent. Spikelets paired; homomorphic; abaxial; planoconvex. First glume not fused with the callus; present, or absent; not encircling the spikelet base; not inflated at the base. Rachilla not pronounced below the second glume; not pronounced between the florets. Second glume present, or absent; rounded on the back. Fertile florets 1. Lemma of lower floret membranous; consistent in texture; lacking a central longitudinal groove. Lemma of upper floret chartaceous; minutely muricate; brown; dull; with flat margins; with margins thinner in texture than the body; glabrous; without basal modifications; not differentiated at the apex. C-4. Africa.

Streptolophus Hughes

Plants hermaphroditic; annual. Flowering culms terminated by a solitary inflorescence. Ligule a membrane. Inflorescence a panicle. Main axis with

quaquaversal primary branches. Primary branches appressed to the main axis to reflexed; reduced to a fascicle of spikelets. Rachis terminating in a bristle. Bristles unbranched, or branched. Pedicels cupuliform at the apex; perpendicular with the spikelet base; concave. Disarticulation at the base of the primary branches. Callus not differentiated. Cleistogamous inflorescence absent. Spikelets solitary; homomorphic; abaxial; dorsiventrally compressed. First glume not fused with the callus; present; not encircling the spikelet base; not inflated at the base. Rachilla not pronounced below the second glume; not pronounced between the florets. Second glume present; rounded on the back. Fertile florets 1. Lemma of lower floret membranous to chartaceous; consistent in texture; lacking a central longitudinal groove. Lemma of upper floret cartilaginous; muricate; brown; dull; with involute margins; with margins of the same texture as the body; glabrous; without basal modifications; not differentiated at the apex. C-4. Africa.

Tarigidia Stent

Plants hermaphroditic; perennial. Flowering culms terminated by a solitary inflorescence. Ligule a membrane. Inflorescence a panicle. Main axis with quaquaversal primary branches. Primary branches appressed to the main axis; with appressed secondary branches. Rachis terminating in a spikelet. Pedicels perpendicular with the spikelet base. Disarticulation at the base of the primary branches. Callus differentiated. Cleistogamous inflorescence absent. Spikelets solitary, or paired; homomorphic; abaxial; planoconvex. First glume not fused with the callus; present; not encircling the spikelet base; not inflated at the base. Rachilla not pronounced below the second glume; not pronounced between the florets. Second glume present; rounded on the back; indumentum not uncinate. Fertile florets 1. Lemma of lower floret membranous; consistent in texture; lacking a central longitudinal groove. Lemma of upper floret chartaceous; smooth; black, or yellow; dull; with flat margins; with margins thinner in texture than the body; glabrous; without basal modifications; not differentiated at the apex. C-4. Africa.

Thuarea Pers.

Plants monoecious, or andromonoecious; perennial. Flowering culms terminated by a solitary inflorescence. Ligule a fringe of hairs. Inflorescence a raceme. Rachis terminating in a spikelet, or terminating in an unmodified naked point. Pedicels not applicable (not clearly differentiated); perpendicular with the spikelet base; flat. Disarticulation at the base of the inflorescence (with a secondary point at the base of the terminal spikelets). Callus differentiated. Cleistogamous inflorescence absent. Spikelets solitary; homomorphic; adaxial; dorsiventrally compressed. First glume not fused with the callus; present, or absent; not encircling the spikelet base; not inflated at the base. Rachilla not pronounced

below the second glume; not pronounced between the florets. Second glume present; rounded on the back; indumentum not uncinate. Fertile florets 1. Lemma of lower floret membranous; consistent in texture; lacking a central longitudinal groove. Lemma of upper floret cartilaginous to indurate; smooth; yellow; dull; with flat margins; with margins of the same texture as the body; glabrous; without basal modifications; not differentiated at the apex. C-4. Africa, Asia, and Australia.

Thyridachne C.E. Hubb.

Plants hermaphroditic; annual. Flowering culms terminated by a solitary inflorescence. Ligule a membrane. Inflorescence a panicle. Main axis with quaquaversal primary branches. Primary branches appressed to the main axis; with appressed secondary branches. Rachis terminating in a spikelet. Pedicels cupuliform at the apex; perpendicular with the spikelet base; concave. Disarticulation at the spikelet base. Callus not differentiated. Cleistogamous inflorescence absent. Spikelets solitary; homomorphic; abaxial; dorsiventrally compressed. First glume not fused with the callus; present; encircling the spikelet base; not inflated at the base. Rachilla not pronounced below the second glume; not pronounced between the florets. Second glume present; rounded on the back. Fertile florets 1. Lemma of lower floret membranous to chartaceous; with the area between the central nerve and the first lateral nerve thinner in texture than the rest of the structure; with a central longitudinal groove. Lemma of upper floret cartilaginous; smooth; yellow; dull; with flat margins; with margins of the same texture as the body; glabrous; without basal modifications; not differentiated at the apex. C-3. Africa.

Thyridolepis S.T. Blake

Plants hermaphroditic; perennial. Flowering culms terminated by a solitary inflorescence. Ligule a fringe of hairs. Inflorescence a raceme. Rachis terminating in a spikelet. Pedicels discoid at the apex; perpendicular with the spikelet base, or oblique to the spikelet base; concave. Disarticulation at the spikelet base. Callus differentiated. Cleistogamous inflorescence absent. Spikelets solitary; homomorphic; abaxial; planoconvex. First glume not fused with the callus; present; encircling the spikelet base; not inflated at the base. Rachilla pronounced below the second glume; not pronounced between the florets. Second glume present; rounded on the back; indumentum not uncinate. Fertile florets 1. Lemma of lower floret membranous to chartaceous; consistent in texture; lacking a central longitudinal groove. Lemma of upper floret chartaceous to cartilaginous; striate; brown; dull; with flat margins; with margins thinner in texture than the body to with margins of the same texture as the body; glabrous; without basal modifications; differentiated at the apex. C-3. Base chromosome number, x = 9. Australia.

Trachys Pers.

Plants hermaphroditic; annual, or perennial. Flowering culms terminated by a solitary inflorescence. Ligule a membrane. Inflorescence a panicle. Main axis with secund primary branches. Primary branches appressed to the main axis; reduced to a fascicle of spikelets. Rachis terminating in a spikelet. Pedicels perpendicular with the spikelet base. Disarticulation at the nodes of the main axis, or at the nodes of the primary branches. Callus not differentiated. Cleistogamous inflorescence absent. Spikelets in clusters of 4 or more; homomorphic; abaxial; dorsiventrally compressed (dorsally flattened). First glume not fused with the callus; present; not encircling the spikelet base; not inflated at the base. Rachilla not pronounced below the second glume; not pronounced between the florets. Second glume present; rounded on the back; indumentum not uncinate. Fertile florets 1. Lemma of lower floret cartilaginous; consistent in texture; lacking a central longitudinal groove. Lemma of upper floret chartaceous; smooth (minutely muricate); brown; dull; with flat margins (slightly involute); with margins thinner in texture than the body to with margins of the same texture as the body; glabrous; without basal modifications; not differentiated at the apex. C-4. Asia.

Tricholaena Schult.

Plants hermaphroditic; perennial. Flowering culms terminated by a solitary inflorescence. Ligule a fringe of hairs. Inflorescence a panicle. Main axis with distichous primary branches, or with secund primary branches. Primary branches spreading; with spreading secondary branches. Rachis terminating in a spikelet. Pedicels discoid at the apex; perpendicular with the spikelet base; concave. Disarticulation above the lower glume, or at the spikelet base; at the base of the floret. Callus minutely differentiated. Cleistogamous inflorescence absent. Spikelets solitary; homomorphic; probably abaxial; dorsiventrally compressed. First glume not fused with the callus; absent (or minute). Rachilla not pronounced between the florets. Second glume present; rounded on the back; indumentum not uncinate. Fertile florets 1. Lemma of lower floret membranous; consistent in texture; lacking a central longitudinal groove. Lemma of upper floret cartilaginous; smooth; yellow; shiny; with involute margins; with margins of the same texture as the body; glabrous; without basal modifications; not differentiated at the apex. C-4. Base chromosome number, x = 9. Africa and Asia.

Uranthoecium Stapf

Plants hermaphroditic; annual. Flowering culms terminated by a solitary inflorescence. Ligule a fringe of hairs. Inflorescence a panicle. Main axis with distichous primary branches. Primary branches appressed to the main axis; with appressed secondary branches. Rachis terminating in an unmodified naked point. Bristles unbranched. Pedicels discoid at the apex; perpendicular with the spikelet

base; concave to flat. Disarticulation at the nodes of the main axis (with a secondary point at the spikelet base). Callus not differentiated. Cleistogamous inflorescence absent. Spikelets solitary; homomorphic; abaxial; planoconvex. First glume not fused with the callus; present; not encircling the spikelet base; not inflated at the base. Rachilla not pronounced below the second glume; not pronounced between the florets. Second glume present; rounded on the back. Fertile florets 1. Lemma of lower floret chartaceous; with the area between the central nerve and the first lateral nerve thinner in texture than the rest of the structure; with a central longitudinal groove. Lemma of upper floret indurate; rugose; yellow; dull; with flat margins to with involute margins; with margins thinner in texture than the body to with margins of the same texture as the body; glabrous; without basal modifications; not differentiated at the apex. C-4. Base chromosome number, x = 7, or 9, or 15. Australia.

Urochloa P. Beauv.—see WEBSTER (1988).

Whiteochloa C.E. Hubb.

Plants dioecious; annual, or perennial. Flowering culms terminated by a solitary inflorescence. Ligule a fringe of hairs. Inflorescence a panicle. Main axis with quaquaversal primary branches. Primary branches appressed to the main axis, or spreading; with appressed secondary branches, or with spreading secondary branches. Rachis terminating in a spikelet. Pedicels discoid at the apex, or cupuliform at the apex; perpendicular with the spikelet base; concave. Disarticulation at the spikelet base. Callus differentiated, or not differentiated. Cleistogamous inflorescence absent. Spikelets solitary; homomorphic; adaxial; laterally compressed. First glume not fused with the callus; present; encircling the spikelet base; inflated at the base, or not inflated at the base. Rachilla pronounced below the second glume, or not pronounced below the second glume; pronounced between the florets; lacking lateral appendages. Second glume present; rounded on the back; indumentum not uncinate. Fertile florets 1. Lemma of lower floret membranous to cartilaginous; with a hyaline area at the base; lacking a central longitudinal groove. Lemma of upper floret cartilaginous to indurate; smooth, or rugose; white, or yellow; dull; with involute margins; with margins of the same texture as the body; glabrous; constricted at the base, or without basal modifications; not differentiated at the apex. C-4. Australia.

Xerochloa R. Br.

Plants hermaphroditic; annual, or perennial. Flowering culms with inflorescences in a spatheate raceme. Ligule a fringe of hairs. Inflorescence a spike, or a solitary spikelet. Main axis with quaquaversal primary branches. Rachis terminating in an unmodified naked point. Pedicels perpendicular with the spikelet base. Disarticulation at the base of the inflorescence. Callus differentiated.

Cleistogamous inflorescence absent. Spikelets solitary; homomorphic; abaxial; laterally compressed to dorsiventrally compressed. First glume not fused with the callus; present, or absent; not encircling the spikelet base; not inflated at the base. Rachilla not pronounced below the second glume; not pronounced between the florets. Second glume present; rounded on the back; indumentum not uncinate. Fertile florets 1. Lemma of lower floret membranous to cartilaginous; with a hyaline area at the base; lacking a central longitudinal groove. Lemma of upper floret membranous to cartilaginous; smooth, or striate, or muricate; white to brown; dull; with flat margins; with margins thinner in texture than the body, or with margins of the same texture as the body; glabrous; without basal modifications; not differentiated at the apex. C-4. Australia.

Yakirra Lazarides & R. Webster

Plants hermaphroditic; annual, or perennial. Flowering culms terminated by a solitary inflorescence. Ligule a fringe of hairs. Inflorescence a panicle (rarely a raceme). Main axis with quaquaversal primary branches. Primary branches appressed to the main axis, or spreading; with appressed secondary branches, or with spreading secondary branches. Rachis terminating in a spikelet. Pedicels cupuliform at the apex; perpendicular with the spikelet base; concave. Disarticulation above the lower glume, or at the spikelet base. Callus not differentiated. Cleistogamous inflorescence absent. Spikelets solitary; homomorphic; adaxial; dorsiventrally compressed. First glume not fused with the callus; present; encircling the spikelet base; not inflated at the base. Rachilla pronounced below the second glume; pronounced between the florets; with lateral appendages, or lacking lateral appendages. Second glume present; rounded on the back. Fertile florets 1. Lemma of lower floret membranous; consistent in texture; lacking a central longitudinal groove. Lemma of upper floret indurate; smooth; brown to yellow; dull; with involute margins; with margins of the same texture as the body; glabrous; without basal modifications; not differentiated at the apex. C-3. Australia.

Yvesia A. Camus

Plants hermaphroditic; annual. Flowering culms terminated by a solitary inflorescence. Ligule a fringe of hairs. Inflorescence a panicle. Main axis with quaquaversal primary branches. Primary branches appressed to the main axis, or spreading; with appressed secondary branches. Rachis terminating in a spikelet. Pedicels discoid at the apex; perpendicular with the spikelet base; concave. Disarticulation at the spikelet base. Callus not differentiated. Cleistogamous inflorescence absent. Spikelets solitary; homomorphic; adaxial; dorsiventrally compressed. First glume not fused with the callus; absent. Rachilla not pronounced below the second glume; not pronounced between the florets. Second

glume present; rounded on the back; indumentum not uncinate. Fertile florets 1. Lemma of lower floret membranous; consistent in texture; lacking a central longitudinal groove. Lemma of upper floret cartilaginous; minutely muricate; yellow; dull; with involute margins (becoming flat); with margins of the same texture as the body; glabrous; without basal modifications; not differentiated at the apex. C-4. Africa.

Zygochloa S.T. Blake

Plants dioecious; perennial. Flowering culms with inflorescences densely clustered in a spatheate panicle. Ligule a fringe of hairs. Inflorescence a solitary spikelet. Rachis terminating in an unmodified naked point. Pedicels discoid at the apex; perpendicular with the spikelet base; concave to flat. Disarticulation at the spikelet base and at the culm nodes. Callus not differentiated. Cleistogamous inflorescence absent. Spikelets solitary; homomorphic; dorsiventrally compressed. First glume not fused with the callus; present; encircling the spikelet base; not inflated at the base. Rachilla pronounced below the second glume; not pronounced between the florets. Second glume present; rounded on the back; indumentum not uncinate. Lemma of lower floret chartaceous; consistent in texture; lacking a central longitudinal groove. Lemma of upper floret indurate; smooth to striate; yellow; with involute margins; with margins of the same texture as the body; glabrous; constricted at the base; not differentiated at the apex. Australia.

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A NEW DISJUNCT VARIETY OF *CROTON ALABAMENSIS* (EUPHORBIACEAE) FROM TEXAS

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ABSTRACT

Croton alabamensis, formerly known only from Alabama in Bibb and Tuscaloosa counties, with one report from Coffee County, Tennessee, has been found in Texas in Coryell and Travis counties. The Texas plants are here described as *C. alabamensis* var. *texensis.* As in Alabama the plants occur in dense local populations generally as understory shrubs beneath hardwood dominated forest and typically grow in shallow soils over limestone. The possibility that a long distance dispersal event was responsible for the present distribution is discussed.

RESUMEN

Croton alabamensis, anteriormente conocido solo de los condados Bibb y Tuscaloosa, Alabama, con un reporte del Condado Coffee, Tennessee, ha sido encontrado en los condados de Coryell y Travis en Texas. Las plantas de Texas se describen aquí como *C. alabamensis* var. *texensis.* Como en Alabama, las plantas ocurren en poblaciones locales densas generalmente como arbustos del sotobosque debajo de bosque predominantemente caducifolio y tipicamente crecen en suelos poco profundos sobre un substrato de piedra caliza. Se discute la posibilidad de un evento de dispersion a larga distancia como responsable de la presente distribución exhibida por este taxón.

KEY WORDS: *Croton,* Euphorbiaceae, Texas

INTRODUCTION

Croton alabamensis E.A. Smith ex Chapman was first discovered in Texas in April 1989 by Carol Beardmore and Rex Wahl at Fort Hood Military Reservation, Coryell County. Chuck Sexton independently discovered a population on Post Oak Ridge in northwest Travis County in June 1989 and brought a specimen to me which I matched at TEX with *Croton alabamensis.* Later, a second Travis County population was found by Pat McNeil 4.4 mi south-southwest of the first. After visiting the three Texas populations and the type locality in Alabama, I have determined the Texas plants to be sufficiently distinct to merit varietal status.

TAXONOMIC TREATMENT

A key to the varieties is provided below with a full description for *Croton alabamensis* var. *texensis.*

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Croton alabamensis E.A. Smith ex Chapman, Fl. South. U.S., 2nd ed. 1883.—
LECTOTYPE: To be selected (Wurdack in prep.). There were no specimens cited in Chapman's protologue. The original material of *Croton alabamensis* was collected by Eugene A. Smith in July 1877 (Wurdack in prep.) near Pratt's Ferry, Bibb County, Alabama not far from the eastern bank of the Little Cahaba River (Mohr 1889).

KEY TO VARIETIES OF *CROTON ALABAMENSIS*

1. Scale-covered surfaces silver, covered by scales of a mixture of pigmentation types; scales mostly unpigmented or light amber and lacking dark centers, scattered scales dark blackish-brown; flowers per inflorescence 9 – 18, fruits per infructescence 0 – 11 ..... *C. alabamensis* var. *alabamensis*
1. Scale-covered surfaces copper-colored, covered by scales of a mixture of pigmentation types; scales unpigmented or with dark reddish-brown centers (basal cells) and reddish-amber rays; flowers per inflorescence 6 – 14, fruits per infructescence 0 – 6 ..... *C. alabamensis* var. *texensis*

Croton alabamensis E.A. Smith ex Chapman var. **alabamensis**

Distribution. Alabama and Tennessee. In Alabama known only from Bibb County, Cahaba River valley (seven populations) and from Tuscaloosa County, Warrior River valley (three populations). There is one collection from Tennessee: Coffee County, Tullahoma, 10 Aug 1899, *T.G. Harbison 725* (NCU, not seen) (Farmer & Thomas 1969). The plants occur on shallow-soiled valley slopes in dense thickets covering up to 15 acres (McDaniel 1981). Populations along the Cahaba River occur on Ordovician limestone; those along the Warrior River are found on Pennsylvanian shale and sandstone. They begin flowering in late February with peak flowering in mid-March. Flower buds form during May and June which will not open until the following year. Fruits have matured and dehisced by early June (Farmer 1962).

Croton alabamensis E.A. Smith ex Chapman var. **texensis** Ginzbarg, var. nov. (Fig. 1).

Croton alabamensis E.A. Smith ex Chapman var. *alabamensis* similis sed differt paginis squamis obtectis cupreis vs. argenteis, squamis plerumque centris atroporphyreis et radiis rubro – succineis vel squamis absque pigmento vs. plerumque absque pigmento vel leviter succineis, floribus 6 – 14 per inflorescentiam vs. 9 – 18, fructibus 0 – 6 per infructescentiam vs. 0 – 11.

Monoecious shrub to 2 m or more tall, much-branched from the base, lower branches sometimes rooting; stems with thin gray bark giving a slightly sweet odor when scratched, leafy only near their tips, new growth angular, with projecting leaf bases; axillary branches normally only 1 – 4 cm long but those just below old inflorescences elongating to form irregular bi(tri)furcations. Indument a mixture of pigmented and unpigmented scales, *the pigmented scales with dark reddish-brown centers and reddish-amber rays, giving a copper-colored appearance to new stems, petioles, lower leaf surface, inflorescence, outer surface of sepals and petals, ovary and capsule, and outer surface of style branches.* Leaves alternate, exstipulate; petioles

FIG. 1. A. Inflorescence with an opened pistillate flower and staminate flowers in bud, scale bar 2 cm *(Ginzbarg 898)*. B. Inflorescence with one pistillate flower at base and staminate flowers above, scale bar 2 cm *(Ginzbarg 898)*. C. Fruit, scale bar 1 cm *(Ginzbarg 900)*. D. Habit *(Ginzbarg 898)*.

0.6 – 1.9 mm long, canaliculate; blades ovate or elliptic, 3.8 – 9.0 cm long, 1.5 – 4.0 cm wide, entire; apex acute, rounded or emarginate; base obtuse to slightly cordate, glandless; upper surface dark green with scattered scales, midvein canaliculate; lower surface with prominent midvein and lower lateral veins. *Inflorescence a terminal* 6 – 14 *flowered raceme,* 1.9 – 3.3 cm long with pistillate flowers near the base and staminate flowers above; early flowering racemes with 0 – 1 pistillate flower and 5 – 12 staminate flowers; later flowering racemes with 2 – 6 pistillate flowers and 4 – 10 staminate flowers. Staminate flowers broadly cup-shaped, 5.0 – 8.1 mm in diameter, on pedicels 2.2 – 4.0 mm long, subtended by bracts 1.1 – 3.0 mm long; calyx lobes 5, spreading, triangular, cymbiform at apex, 1.1 – 2.9 mm long, 1.5 – 3.0 mm wide; petals 5, oblong-ovate, cymbiform at apex, stellate ciliate, 2.0 – 3.1 mm long, 1.1 – 2.1 mm wide; stamens (11-)14 – 18(-21), with filaments 2.8 – 5.2 mm long, densely stellate-lanate at base, and anthers 0.6 – 1.2 mm long, composed of convergent anther sacs; disc of 5 pairs of orange glands opposite the sepals, the two glands of each pair lying on either side of the stamens of the outer whorl, narrowing, converging and fusing just outside the filament bases, receptacle glabrous but obscured by the filament base hairs. Pistillate flowers on pedicels 2.2 – 7.4 mm long, subtended by spatulate, apically rounded bracts 1.6 – 6.0 mm long; sepals closely enveloping ovary, ascending, cymbiform at apex, 2.0 – 4.5 mm long, 2.0 – 3.1 mm wide; petals ovate from a narrow base, cymbiform at apex, stellate ciliate, 2.0 – 3.0 mm long, 1.1 – 1.9 mm wide; disc of 5 orange semilunar glands opposite the sepals, 1.0 – 2.1 mm tangentially, 0.4 – 0.7 mm radially; ovary superior, depressed spheroidal, 1.6 – 2.5 mm tall, 2.0 – 3.0 mm wide; styles 3, recurved, connate at base for 0.2 – 0.7 mm, 2.0 – 5.0 mm long, furrowed and yellow (turning reddish brown with age) adaxially, once (twice) divided, first division (0.1-)0.5 – 2.0 mm from apex, second division 0.0 – 1.0 mm from apex. Capsules light brown, on pedicels 7.0 – 10.6 mm long, depressed spheroidal, weakly 3 – (-4) lobed apically, columella 6.8 – 9.5 mm long; seed elliptic tangentially, mucronate apically, back rounded, adaxial faces converging at a wide angle, 6.7 – 7.9 mm long, 5.2 – 6.0 mm wide, chestnut brown with white blotches and streaks, caruncle yellow, 1.2 – 2.4 mm long, 1.9 – 2.6 mm wide, above a prominent white keel at the point of attachment. Flowering Feb – Mar. Fruiting May. Fruits have dehisced by early June.

Distribution. Texas, eastern edge of the Edwards Plateau. Known only from Travis and Coryell counties.

Ecology. The plants form dense local thickets as understory shrubs in mesic canyon hardwood forests or in full sun. Flower buds form in May and overwinter, blooming the following spring. Canyon slopes are generally characterized by shallow, moderately alkaline, gravelly or stony clay or clay – loam overlying Cretaceous limestone. Soils are well drained, permeability moderate and available water capacity low (McCaleb 1985, Werchan et al. 1974).

TYPE: TEXAS. Travis Co.: Gainer Ranch, 6 mi W of Liberty Hill on RR 1869, then 6.4 mi S to gate, then 2 mi SE (5 air mi SW of Liberty Hill), NE facing drainage and adjacent plateau, 365 m, 30° 36' 24" N 97° 58' 33" W, 3 Mar 1990, *Ginzbarg 898* (HOLOTYPE: TEX; ISOTYPES: BRIT/SMU, F, GA, IBE, MO, NY, UNA, US, VDB).

Additional specimens examined: TEXAS. **Coryell Co.:** Fort Hood Military Reservation, creek bottom, 30 Apr 1989, *Beardmore & Wahl* 056 (TAMU); Fort Hood Military Reservation, 0.6 air mi SSE Cold Springs, S side of Owl Cr., N flank of Owl Cr. Mts., NW slope adjacent to drainage, 31° 14' 02"N 97° 35' 46"W, 25 Oct 1989, *Cornelius s.n.* (TEX). **Travis Co.:** Gainer Ranch, 6 mi W of Liberty Hill on RR 1869, then 6.4 mi S to gate, then 2 mi SE (5 air mi SW of Liberty Hill.), NE facing drainage and adjacent plateau, 365 m, 30° 36' 24"N 97° 58' 33"W; 15 Jun 1989, *Enquist 495* (SMU, TAES, TEX); 13 Jun 1989, *Ginzbarg 895* (IBE, TEX, UNA); 12 Aug 1989, *Ginzbarg 896* (TEX); 12 Aug 1989, *Ginzbarg 897* (IBE, TEX, UNA); 8 May 1990, *Ginzbarg 900* (BRIT/SMU, GA, IBE, MO, TEX, UNA, US, VDB); 6 Jun 1989, *Sexton s.n.* (TEX); adjacent to Penn Ranch (a.k.a. Sunset Ranch), W side of Post Oak Ridge, NW facing canyon, ca. 0.6 mi N, 0.3 mi W of Hanging Rock Spring, 305 – 365 m, 30° 32' 45"N 97° 59' 47"W, 15 May 1991, *Carr 11153* (TEX); 7 Mar 1990, *Ginzbarg 899* (IBE, MO, NY, TEX, UNA, US, VDB).

Population site descriptions. In Travis County, the plants occur mostly in deciduous forest in mesic limestone canyons and on slopes. Some plants are also found on adjacent drier slopes with Ashe Juniper woodlands and Glen Rose outcrop grassland flora. Populations occur on Cretaceous limestone. Most plants are found in canyons and slopes on upper Glen Rose Formation. Those plants found on adjacent plateau rimrock are on Walnut Formation, Bee Cave Member (marl) and Edwards Formation.

The Gainer Ranch population has about 500 – 1000 plants. Most plants are in canyon forest under *Quercus buckleyi* and *Fraxinus texensis* but at the head of the canyon they are also found in full sun on the adjacent plateau. The population ends abruptly part way down the canyon with the disappearance of limestone rock outcrops. *Croton alabamensis* is the dominant shrub at the site. The dominant shrub in a nearby canyon where *Croton alabamensis* was not found is *Garrya lindheimeri.* Canyon soils are rocky and contain considerable humus. They are mapped as Tarrant soils and Rock outcrop, steep (TdF) (Werchan et al. 1974).

The Penn Ranch main population has several thousand individuals most common on nearly level terraces, but also extending upslope. Canyon forest canopy is dominated by hardwoods, mostly *Quercus buckleyi* and some *Ulmus americana;* adjacent drier areas are dominated by *Juniperus ashei.* Shrub layer in hardwood areas is dominated by *Croton alabamensis, Ilex vomitoria,* and *Garrya lindheimeri.* Ground cover is sparse under yaupon and *Croton alabamensis* thickets consisting mainly of scattered *Carex planostachys.* Diversity is greater on more open slopes. Other associated species are listed in Table 1. Soils are clay loam or loam, with considerable duff cover. They are comparatively deep even on slopes, and generally lack stones and gravel although some large flags are present on surface. Soils are mapped as Brackett soils and Rock outcrop, steep (BoF) (Werchan et al. 1974), but the soils within the canyon are of an unmapped series. A smaller population of about 100 plants was seen near the top of a north to west-

facing slope in next drainage to the south (about 0.2 air miles north, 0.35 air miles west of Hanging Rock Spring. *Croton alabamensis* at this site does not occur on terraces but grows under a band of deciduous trees (possibly on a seep zone) on an upper slope otherwise dominated by *Juniperus ashei.* Scattered individuals were also seen in old clearings in "cedar brakes" on dry shallow Brackett soils. (Observations of the Penn Ranch population follow from Carr 1991.)

In Coryell County, The Fort Hood main population probably has several thousand plants. It was not possible during my visit to traverse the full extent of the population. A second population (not seen) is located in another canyon about 1.1 miles east at 31° 14' 02"N 97° 36' 39"W. Associated species are listed in Table 1. Populations occur on Cretaceous limestone. Most plants are found in canyons and slopes on Walnut clay and Comanche Peak limestone. Any plants found on adjacent plateau rimrock would be on undifferentiated Washita (or Edwards) limestone. Soils are mapped as Real – Rock outcrop complex (ReF) (McCaleb 1985).

TABLE 1. Plants associated with *Croton alabamensis* var *texensis.* Species observed primarily in Texas Oak Series mesic limestone canyon forest community (Diamond 1992) are indicated by TO; species observed primarily in Ashe Juniper-Oak Series woodland/grassland on adjacent drier slopes are indicated by AJO; a few herbaceous species seen mostly in creekbeds are indicated by CB; species not primarily restricted to one community are indicated by X. Species lists for the Penn Ranch site were contributed by Bill Carr; those for Gainer Ranch and Ft. Hood sites were contributed by Jackie Poole.

WOODY PLANTS	Gainer	Penn	Ft. Hood
Baccharis neglecta	TO		
Berberis trifoliolata		AJO	
Bumelia lanuginosa	TO	X	TO
Celtis laevigata	TO		
Cercis canadensis	TO	TO	TO
Cornus drummondii		TO	
Croton alabamensis	TO	TO	TO
Diospyros texana	TO	AJO	
Eupatorium havanense	TO	TO	
Eupatorium sp.	TO		
Eysenhardtia texana		AJO	
Forestiera pubescens	TO	X	
Fraxinus texensis	TO	TO	TO
Garrya lindheimeri		TO	
Ilex decidua	TO	TO	TO
Ilex vomitoria		TO	TO
Juglans microcarpa		TO	
Juniperus ashei	TO	X	TO
Mimosa borealis		AJO	
Morus microphylla		TO	
Nolina lindheimeriana		AJO	
Opuntia lindheimeri		TO	
Parthenocissus quinquefolia		X	
Platanus occidentalis		TO	
Prunus mexicana		TO	

WOODY PLANTS	Gainer	Penn	Ft. Hood
Prunus serotina		TO	
Ptelea trifoliata	TO	TO	
Quercus buckleyi	TO	TO	TO
Quercus fusiformis			TO
Quercus muhlenbergii		TO	
Quercus sinuata var breviloba	X	X	TO
Rhamnus caroliniana		TO	TO
Rhus aromatica		X	
Rhus toxicodendron	TO	X	TO
Rhus virens		AJO	TO
Rubus trivialis	TO	X	
Sapindus saponaria		TO	
Smilax bona-nox	TO	X	
Ulmus americana		TO	
Ulmus crassifolia	TO	TO	TO
Ungnadia speciosa		TO	
Viburnum rufidulum	TO	TO	
Vitis berlandieri	TO		
Vitis sp.		X	TO
Yucca rupicola	AJO		
GRASSES/SEDGES			
Bothriochloa barbinervis	TO		
Bouteloua pectinata		AJO	
Carex edwardsiana		TO	
Carex microdonta		CB	
Carex planostachys		X	TO
Dichanthelium lindheimeri		CB	
Dichanthelium pedicellatum	X		
Dichanthelium sp.		TO	
Eleocharis acutisquamata		AJO	
Eleocharis montevidensis		CB	
Erioneuron pilosum		AJO	
Muhlenbergia lindheimeri		CB	
Muhlenbergia reverchonii		AJO	
Panicum virgatum		CB	
Schizachyrium scoparium		AJO	
FORBES			
Agalinis edwardsiana		AJO	
Anemone edwardsiana		TO	
Anemone heterophylla			TO
Aristolochia serpentaria		TO	
Argythamnia simulans		X	
Asclepias oenotheroides		AJO	
Brickellia cylindracea		X	
Clematis texensis		TO	
Commelinantia anomala		TO	
Daucosma laciniatum		X	
Desmodium psilophyllum		TO	
Desmodium sp.			TO
Euphorbia angusta		AJO	
Euphorbia fendleri		AJO	

(TABLE 1 continued)

WOODY PLANTS	Gainer	Penn	Ft. Hood
Galium aparine	TO	X	
Galium circaezans			TO
Galium texense?	TO		
Hedeoma acinoides		X	
Hedeoma drummondii		AJO	
Hedyotis nigricans		AJO	
Krameria lanceolata		AJO	
Lactuca serriola	TO		
Lespedeza texana		X	
Linum rupestre		AJO	
Lithospermum incisum		AJO	
Lonicera albiflora	TO		TO
Matelea reticulata	TO	X	
Melampodium leucanthum		AJO	
Onosmodium helleri		TO	
Oxalis dillenii		X	
Parietaria obtusa		X	
Parietaria pensylvanica	TO		
Passiflora lutea		X	
Passiflora sp.	TO		
Physalis viscosa		X	
Pinaropappus roseus		X	
Polygala lindheimeri		X	
Psoralea latestipulata		AJO	
Psoralea tenuiflora		AJO	
Ruellia humilis		X	
Salvia engelmannii		AJO	
Salvia roemeriana		TO	TO
Scutellaria drummondii		X	
Senecio obovatus		TO	
Senecio obovatus?			TO
Silphium albiflorum		AJO	
Sisyrinchium ensigerum		AJO	
Solidago nemoralis		AJO	
Stillingia texana		AJO	
Thelesperma simplicifolium		AJO	
Tragia ramosa		X	
Triodanis coloradoensis		X	
Verbesina lindheimeri		X	
Verbesina virginica	TO	X	
Vicia sp.	TO		TO
Zexmania hispida		X	
Zigadenus nuttallii	TO		
FERNS			
Adiantum capillus-veneris		TO	
Asplenium resiliens		TO	
Cheilanthes alabamensis		X	
Pellaea atropurpurea		X	

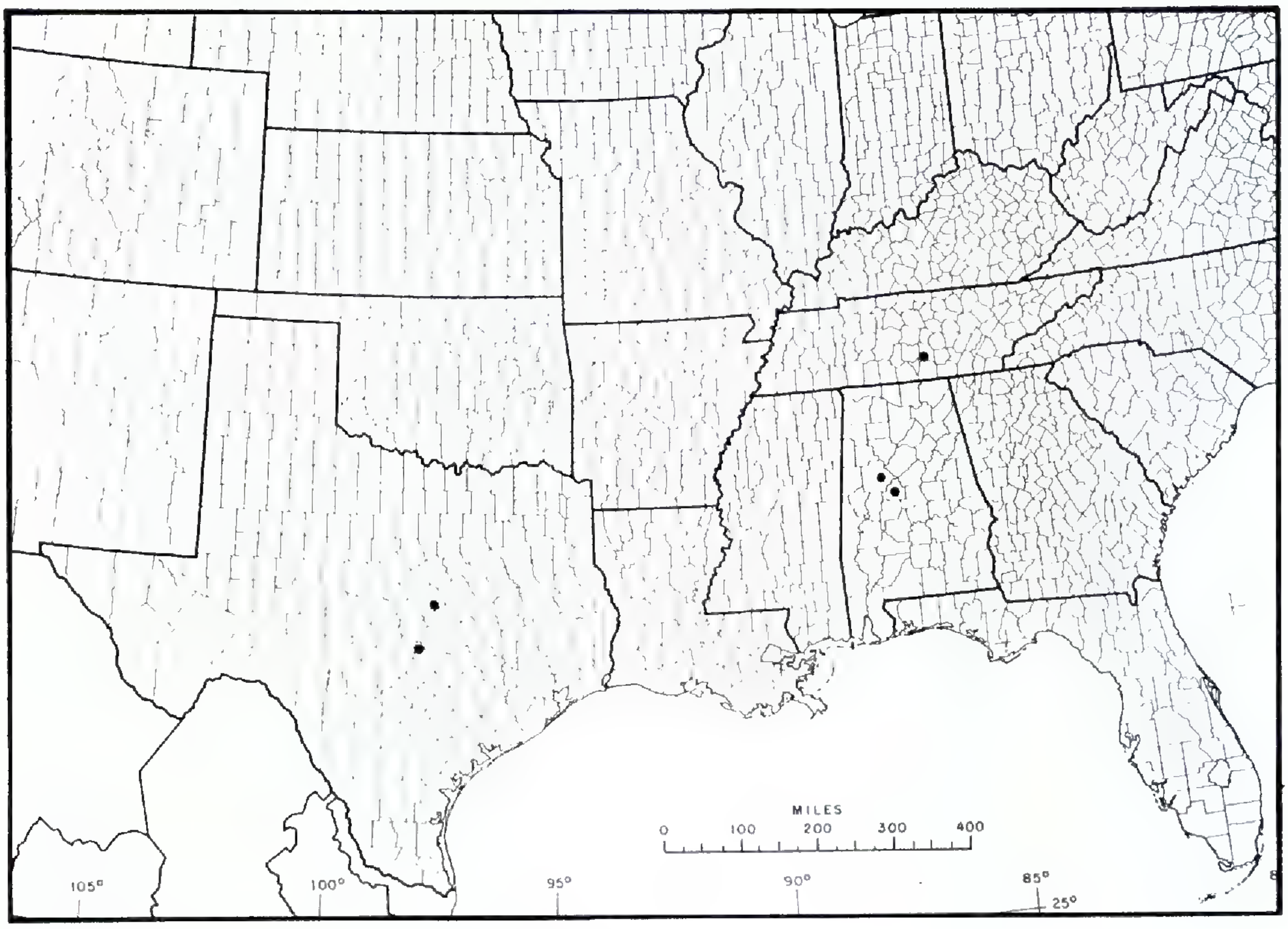

FIG. 2. Distribution of *Croton alabamensis.*

BIOGEOGRAPHY

The Texas populations of *Croton alabamensis* are separated from the Alabama populations by nearly a thousand kilometers (Fig. 2), a remarkable disjunction considering that so few populations are known. One possible explanation is that the range of *Croton alabamensis* was once much more extensive and the present distribution is relictual. During the Wisconsin Glaciation a temperate forest belt extended along the Gulf Coast (possibly broken by a southern extension of boreal forest along the lower Mississippi Alluvial Valley). Within this belt deciduous forest species would have found refuge in fire protected mesic habitats such as river bluffs. Glacial retreat was accompanied by a shift in patterns of atmospheric circulation. Influenced by the dry Pacific airmass, prairie first appeared in Texas about 12,000 yr B. P. (Delcourt & Delcourt 1987). *Croton alabamensis* is thin-barked and probably not fire tolerant (Kral 1983). It is doubtful that it could have survived frequent prairie fires. Relictual populations of *Croton alabamensis* could have survived in mesic ravines of the Edwards plateau.

The hypothesis of a relictual distribution, proposed by Mohr (1901), is supported by the fact that other species show similar distributions. Climatic change could cause species with similar habitat requirements to retreat to the same areas. *Andrachne phyllanthoides* and *Cotinus obovatus* exhibit a disjunction similar to that of *Croton alabamensis* between the Edwards Plateau in Texas and the

Appalachian Plateau in Alabama but are also known from the Ozark Plateau of Arkansas and adjacent Missouri and Oklahoma (distributions provided by Steve Orzell and Edwin Bridges). Although the similarities of the distributions of these species suggest a relictual distribution, it is equally plausible that the species occur in the same areas because these have colonized present day "islands" of suitable habitat.

The present distribution of *C. alabamensis* is more easily explained as the result of a relatively recent introduction by long distance dispersal. The local distribution of *Croton alabamensis* is characterized by exceedingly rare but very dense populations which appear to be thriving. The species is not present in many apparently suitable sites near the known populations. A relict species with a long history in the area would have had time to invade these sites unless it had come close to extinction and is now making a comeback. The density of the colonies suggests that the usual mode of seed dispersal is probably the explosive dehiscence of the capsules without significant secondary dispersal. Some vegetative propagation by root-layering of the lower branches also occurs. Although Farmer (1962) reports that root layering was never observed in the Alabama populations, I did observe it at the type locality in Alabama and at the Gainer Ranch population in Texas. Rare secondary dispersal of seeds could have led to the establishment of new colonies. Croton seeds are eaten by Mourning and White-winged doves and quail (Johnston, 1959). Seeds passing through the gut intact could found new colonies locally. It is not inconceivable that Passenger pigeons, once the most abundant bird in North America, could have carried seeds eaten in Alabama to Texas during their fall migration. Although central Texas was on the western periphery of their normal winter range (Bent 1932), in some years large flocks made forays here, stopping to roost where they found suitable habitat. Passenger pigeons were reported from both Travis and Coryell counties (Oberholser 1974). The minor morphological differences between the Texas and Alabama plants could have arisen by founder effect followed by mutation and genetic drift over a relatively short divergence time.

TAXONOMIC RELATIONSHIPS

Croton alabamensis belongs to sect. *Eluteria* Grisebach (sect. *Andrichnia* Baillon). This section is characterized by the presence of petals in pistillate flowers, a condition which may be primitive within the genus. All other crotons have pistillate flowers with petals rudimentary or lacking. As treated by Mueller (1866) the section consists of 25 species, 17 with lepidote and 8 with stellate pubescence. The stellate species are from Madagascar, Mauritius, and west Africa. Seven of the lepidote species are from Africa, Madagascar, and India and possess petiolar glands. The remaining 10 lepidote species are neotropical and lack petiolar glands. *Croton alabamensis* is the only member of this section found in the U.S. although Croizat (1945) has suggested that *Croton argyranthemus* which lacks

petals in the pistillate flowers may be related to this group. Of the lepidote species within sect. *Eluteria* there are only two other species with styles divided only once (Mueller 1866). These are *Croton joufra* Roxburgh from India, which has petiolar glands, and *Croton claussenianus* Baillon from the state of Minas Gerais, Brazil. Croizat (1945) treated the species of sect. *Eluteria* native to the region from Alabama to Panama with emphasis on seed and capsule characters. His key places *Croton alabamensis* closest to the Mexican species *C. pseudochina* Schldl. & Cham. and *C. reflexifolius* Kunth. Further study is needed to shed light on the intriguing biogeography and affinities of *Croton alabamensis.*

ACKNOWLEDGMENTS

I thank Chuck Sexton for calling the plants to my attention, Jackie Poole, Bill Carr, Cary Norquist, Steve Orzell, Edwin Bridges, and Robert Barth for providing me with observations and information, John Cornelius, Pat McNeil, and George Woods for taking me to the Texas and Alabama populations, Jim Fowler, Clif Ladd, and Marshall Enquist for their encouragement, Billie Turner, Beryl Simpson, Marshall Johnston, Linda Escobar, and Carol Todzia for their assistance with the manuscript, Guy Nesom for the Latin diagnosis, Robert Haynes, UNA, and Monique Dubrule, TAMU, for generously loaning specimens.

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A NEW SPECIES OF *MIRABILIS* (NYCTAGINACEAE) FROM MICHOACAN, MEXICO

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ABSTRACT

A new species, *Mirabilis hintoniorum,* belonging to the subgenus *Mirabilis,* is described and illustrated. It is known from only one collection obtained from dense woods in the vicinity of Villa Victoria, District Coalcoman, Michoacan, Mexico.

RESUMEN

Se describe e ilustra una nueva especie, ***Mirabilis hintoniorum,*** perteneciendo al subgénero Mirabilis. Se conoce de una sóla colecta del bosque cerca de Villa Victoria, District Coalcomán, Michoacán, México.

Mirabilis hintoniorum Le Duc, sp. nov. (Fig. 1).

Mirabilis exserta Brandeg. et *M. pringlei* Weatherb. similis sed perianthii lobis redactis, vestimento glabro vel glabrato non glanduloso, et inflorescentia paucifloscula differt.

Herbaceous or suffruticose erect perennials(?), 7 – 8 dm high, the upper branches slender, striate, the nodes puberulent, otherwise glabrous. Mid-stem leaves 5 – 9 cm long, 2.0 – 6.5 cm wide, petioles slender 1 – 2 cm long; blades glabrous, broadly to narrowly ovate, asymmetrically cordate or slightly truncate at the base, the apices acuminate, the margins entire, sparsely ciliolate. Inflorescences terminal, arranged in few-flowered cymes, subtended by sessile or subsessile, ovate to ovate-lanceolate, pubescent, leaves. Involucre one-flowered, slightly accrescent in age, narrowly campanulate, 2 – 3 mm long, glabrous or slightly puberulent, the lobes narrowly triangular, less than 1/2 the length of tube, margin ciliolate, the peduncles 3 – 5 mm long, pubescent. Perianth 2.0 – 2.5 cm long, glabrous or nearly so, orange, dilated upwards, limb 5 – 8 mm broad, the lobes obscure, ciliolate. Stamens 5, ca. twice as long as the perianth. Anthocarp dark brown, oblong-ellipsoid, 6 – 7 mm long, 3 mm wide, constricted at both base and apex, 5-angled, the ridges tuberculate, moderately puberulent.

TYPE: MEXICO. MICHOACAN: Villa Victoria, District Coalcoman, dense woods, 700 m, 11 Jul 1939, *Hinton 13909* (HOLOTYPE: TEX!; ISOTYPES: G, MO, UC).

Research in preparation of a monograph of *Mirabilis* subgenus *Mirabilis* has revealed a heretofore undescribed species *Mirabilis hintoniorum.* The placement of this new species is in subgenus *Mirabilis* because of the following characteristics:

SIDA 15(1): 53 – 55. 1992

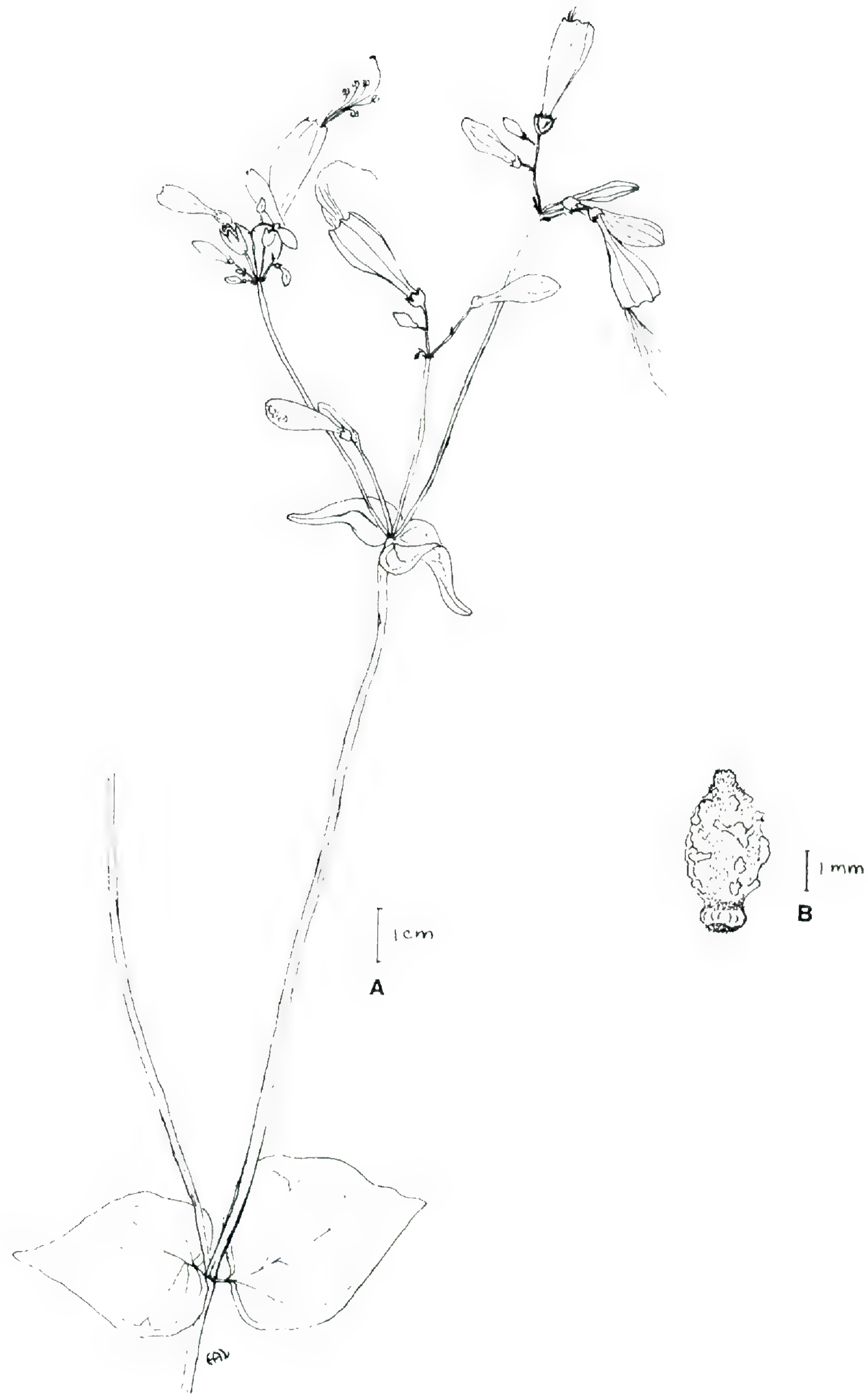

FIG. 1. *Mirabilis hintoniorum* habit and details from holotype. Showing: upper leaves and inflorescence (A), enlarged detail of the anthocarp (B).

single-flowered involucres only slightly accrescent in age, elongate perianth, and long exserted stamens. Within subgenus *Mirabilis,* the open terminal inflorescences and ovate leaves with cordate bases of *M. hintoniorum* closely ally it with *M. exserta* Brandegee and *M. pringlei* Weatherby. However, it differs from these species in the extreme reduction of the perianth lobes, the lack of villous, viscid pubescence, and its few-flowered inflorescences. The anthocarp of *M. hintoniorum* most closely resembles *M. sanguinea* Heimerl, also of subgenus *Mirabilis.* It also shows a resemblance to the anthocarps of *Mirabilis* subgenus *Oxybaphus,* but the involucres of *M. hintoniorum* are only slightly accrescent in age and not membranous, unlike those found in subgenus *Oxybaphus.*

The flower color of this new species, as noted by the collector on the label, is rather unique for the genus, and might have been questioned. However, the author has collected *M. jalapa* L. with orange flowers, a small population just six miles north of Ixtapan del Sal, in the state of Mexico, thus giving credibility to Hinton's notation.

ACKNOWLEDGMENTS

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BOOK REVIEWS

JAIN, S.K. and ROBERT A. DEFILLIPPS. 1991. **Medicinal Plants of India** (Two Vols.). Reference Publications, Inc. 218 St. Clair River Drive, Box 344, Algonac, Michigan, 48001, U.S. $94.95. 847 pp.

This book is the most recent addition to Reference Publications "Medicinal Plants of the World" and focuses on the richness of medicinal plant species on the Indian subcontinent and the role of these species in the health delivery systems of the Indian population. The text surveys plants used in Western, Ayurvedic, and Unami medicine. Plant names are provided in Hindi, Sandskritr, English and in regional dialects. Within the book, both families and genera within families are listed alphabetically for ease of access. Included are medicinal, vernacular name, and botanical indices as well as a bibliography.

This beautifully illustrated book combines the insight of traditional medicine with current scientific though and is an excellent contribution to the field of medicinal botany. *Joe Kuban.*

LA CROIX, I.F., E.A.S. LA CROIX and T.M. LA CROIX. **Orchids of Malawi.** A.A. Balkema Publishers, Old Post Road, Brookfield, Vermont 05036. Hardbound. $70.00. 358 pp.

A very well done book with beautiful photographs on Malawi Orchids. This is also the first book to cover all of the Malawi Orchids. In chapter 1: the authors describes the Climate and Geography. Chapter 2: Includes both Terrestrial and Epiphytic Orchids in their Natural Habitats. Chapter 3: Cultivation. Chapter 4: Describes the Structure of the Orchid Flowers. Chapter 5: Classification. Chapter 6: Key to Genera. There is a list of Malawi Orchids, References and a Glossary. There are 275 illustrations, 283 maps and 120 color plates. This book is a good reference for anyone interested in Malawi Orchids. *Krishna Puttaparthi.*

NABIL EL-HADIDI and LOUTFY BOULOS. **1988. The Street Trees of Egypt.** (ISBN: 977-422-173-8, Revised Edition 1988) 130 pp. (Columbia University Press, 562 West 113th Street, New York, N.Y. 10025). Price: $15.00.

This book is well written by two known Botanists. There are over fifty illustrations of the most common trees of Egypt's cities. This book includes the description of trees, Glossary of Botanical terms, Index to Scientific Names, Index to Vernacular Names, and Arabic Index. This book could be used by foreigners and also the Egyptian students of Botany and Agriculture. *Krishna Puttaparthi.*

ED GRIME, WILLIAM. 1979. **Ethno-Botany of the Black Americans.** Reference Publications, Inc., 218 St. Clair River Drive, Algonac, Michigan 48001. Hardbound, $24.95. 237 pp.

Ethno-Botany is the study of the use of plants by indigenous people and in the case of this book the Black Americans. This book is divided into two major parts. The first part dealing with the plants that the Black people brought with them and the other part describes the native plants they employed on their arrival. This book has ten chapters, includes an index to scientific names and index to common names. This text will be helpful for any studying the Blacks and their contribution of plants. *Krishna Puttaparthi.*

THE TAXONOMIC RESURRECTION OF *QUERCUS LACEYI* SMALL (FAGACEAE)

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ABSTRACT

Quercus laceyi Small, a white oak (*Quercus* sect. *Quercus*) described in 1901 from limestone hills on the southern part of the Edwards Plateau of Texas, has been treated as a synonym of *Quercus glaucoides* Mart. & Gal. in recent literature. However, *Q. laceyi* is clearly a species distinct from *Q. glaucoides,* based on vegetative, floral, fruit, and embryological characters. In addition to the Edwards Plateau, *Q. laceyi* is found on limestone mountains of Nuevo Leon and Coahuila, Mexico, but does not overlap in distribution with *Q. glaucoides* sensu stricto. The latter species has a natural distribution in central and southern Mexico, from San Luis Potosi south to Oaxaca. *Quercus glaucoides* is the type species of subsection *Glaucoideae,* a group of about 30 – 35 species in the southwestern United States, Mexico, and Central America, which share the synapomorphy of fused cotyledons. *Quercus laceyi,* on the other hand, has free cotyledons, and is probably more closely related to the lobed-leaf white oaks (e.g., *Quercus alba* L.) of the eastern United States. A key and descriptions are provided for the two species.

RESUMEN

Quercus laceyi Small, un encino blanco (*Quercus* sect. *Quercus*) descrito en 1901 de colinas calizas en la parte sur de la Planicie Edwards en Texas, ha sido tratado como sinónimo de *Quercus glaucoides* Mart. & Gal. en la literatura reciente. Sin embargo, con base en caracteres vegetativos, florales, fructíferos y embriológicos, es obvio que se trata de dos especies distintas. *Quercus laceyi* se encuentra tanto en la Planicie Edwards como en las montanas calcareas de Nuevo Leon y Coahuila, México, y su distribución no coincide con la de *Q. glaucoides.* Esta ultima especie tiene una distribucion natural en el centro y sur de México, desde San Luis Potosí hacia el sur hasta Oaxaca. *Quercus glaucoides* es la especie tipo de subsección *Glaucoideae,* un grupo de alrededor de 30 – 35 especies en el suroeste de los Estados Unidos, México y América Central, que presentan cotiledones fusionados como sinapomorfismo. *Quercus laceyi,* por otra parte, tiene cotiledones libres, y probablemente está más relacionada con los encinos blancos de hoja lobulada (e.g., *Q. alba* L.) del este de los Estados Unidos. Se proveé una clave y descripciones para las dos especies.

INTRODUCTION

Quercus laceyi Small was based on material from the southern part of the Edwards Plateau of Texas (Small 1901). The species is noteworthy because of the

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striking bluish-green color of the foliage that is similar in color to several other oaks of Mexico and the southwestern United States. Oddly, Trelease (1924), who was otherwise noted for a rather narrow species concept, demoted *Q. laceyi* to *Q. breviloba* Sarg. forma *laceyi* (Small) Trelease. However, *Q. breviloba* is a very different species, now considered by most workers to be a synonym of *Q. sinuata* Walt. var. *breviloba* (Sarg.) Muller (Muller 1970; Dorr & Nixon 1985) and clearly is not closely related to Small's *Q. laceyi*. Muller (1951) accepted the name *Q. laceyi* for the Edwards Plateau material as well as for material from the states of Coahuila and Nuevo Leon in adjacent Mexico. Later, Muller (1970) decided that *Q. laceyi* was a synonym of *Q. glaucoides* Mart. & Gal., a species with bluish-green leaves that is widespread in southern and central Mexico. Recent papers dealing with this species in Texas have continued to use the name *Q. glaucoides*.

Our recent studies of *Q. glaucoides* sensu lato throughout its range in Texas and Mexico have provided several characters that can be used to distinguish the northern populations (*Q. laceyi*) from the southern populations (*Q. glaucoides* sensu stricto). Trees of *Q. glaucoides* from southern and central Mexico have coriaceous, persistent leaves, typically entire, toothed or sometimes shallowly lobed, and fruit that is born on peduncles from 1 – 8 cm in length. In contrast, *Q. laceyi* from Texas and the Mexican states of Nuevo Leon and Coahuila has winter-deciduous, thinner leaves that vary from entire to more deeply lobed, and fruits that are subsessile or born on short peduncles. A broad investigation of embryological characters of white oaks (Nixon 1985) has shown that *Q. laceyi* has free cotyledons in the seeds, in contrast to the fused cotyledons of *Q. glaucoides*. Based on these observations, it is apparent that two species are involved in the broad concept of *Q. glaucoides*, and it is necessary to resurrect the name *Q. laceyi* for material from Texas, Coahuila, and Nuevo Leon. The descriptions of *Q. glaucoides* in recent treatments are confounded by inclusion of *Q. laceyi*, and we present here a key and revised descriptions of the two species, with complete synonymy.

A third species from Nuevo Leon and Tamaulipas, *Q. porphyrogenita* Trel. (syn. *Q. microlepis* Trel. & Mueller), shares the characters of bluish-green leaves and free cotyledons with *Q. laceyi*, and may be one of its closest relatives. *Quercus porphyrogenita* occurs at lower elevations in the eastern foothills of the Sierra Madre Oriental in Tamaulipas and Nuevo Leon, usually on limestone. It is found typically in dry oak woodland and transition to thorn scrub, often in association with *Q. polymorpha* S. & C. and *Q. canbyi* Trel. *Quercus porphyrogenita* and *Q. laceyi* barely overlap in range, in mid-elevation canyons on the eastern side of the Sierra Madre, such as below Galeana in Nuevo Leon. Occasional specimens that appear to be intermediate in leaf characters occur in these areas, but there is no indication that hybridization between these species is common or problematic. *Quercus porphyrogenita* is easily recognized by the combination of narrow, entire leaves, short petioles, strongly cordate leaf bases, and very fine cupule scales, in addition to the elevational and habitat differences of the two species.

Other than *Q. porphyrogenita*, possible relatives of *Q. laceyi* appear to be the lobed-leaf deciduous white oaks of the eastern United States. Of these species, *Q. alba*, with a western distributional limit in east Texas, has foliar features that resemble *Q. laceyi*. Both species have whitish, erect stellate trichomes on the abaxial surface of young expanding leaves. These trichomes are deciduous very early in the season, leaving a glabrous surface on mature leaves. The shape of the leaf base is typically cuneate or tapered in both species, and occasional specimens of *Q. laceyi* from mesic sites bear leaves that approach those of *Q. alba* in depth of lobing.

The probable relationship of *Q. laceyi* to eastern North American deciduous white oaks is consistent with a biogeographic pattern exhibited in several other oak species complexes, as well as numerous other woody genera. Several of the oaks found on the Edwards Plateau are considered to have their closest relatives in species with a generally more eastern distribution. The amount of difference between the Edwards Plateau populations of these taxa and their eastern counterparts varies greatly, and this is reflected in the various taxonomic ranks which they have been accorded. Some exhibit more or less continuous variation with their eastern counterparts, and are recognized as conspecific without varietal rank (e.g. *Q. marilandica* Muench., *Q. muhlenbergii* Engelm., *Q. stellata* Wang.), others conspecific with varietal rank (*Q. sinuata* Walt. var. *breviloba* (Torr.) Muller), or as species distinct from their eastern sister species (*Q. virginiana* Miller [se U.S.] and *Q. fusiformis* Small [Edwards Plateau, ne Mexico], *Q. texana* [syn. *Q. nuttallii* Palmer, see Dorr & Nixon 1985; se U.S.] and *Q. buckleyi* [*Q. texana* of authors; Edwards Plateau and Oklahoma]).

Quercus glaucoides and subsection **Glaucoideae**

While *Q. laceyi* appears to be related to eastern North American oaks, *Q. glaucoides*, on the other hand, is a member of a separate group of Mexican and Southwestern U.S. white oaks. These species consistently have marginally fused cotyledons, waxy leaf epidermis, and erect often stipitate foliar trichomes (Nixon 1985). Additionally, some species in this group, including *Q. glaucoides*, have pilose anthers, in contrast to the glabrous anthers of *Q. laceyi* and most other white oaks. The 30 – 35 species placed in this group were previously placed in 26 different series by Trelease (1924), providing little or no basis for a discussion of their relationships. Nixon (1985) erected *Quercus* subsection *Glaucoideae* (Trelease) Camus emend. Nixon for this group of species. This required expansion of Camus' narrow concept of the subsection, which was essentially the same as series *Glaucoideae* as recognized by Trelease.

Among species of subsection *Glaucoideae*, the degree of fusion of cotyledons varies, and consequently, the central lumen between the cotyledons varies in shape and size. In *Q. glaucoides*, the material observed thus far has a lumen that broadens toward the "base" of the seed/acorn (actually the distal portion relative

to the orientation of the cotyledons and epicotyl), leaving two more or less distinct marginal areas of fusion between the cotyledons. In other species, such as *Q. oblongifolia* Torr., the fused areas are much more complete, with only a narrow central lumen that is often difficult to discern in the field unless the material is sectioned fresh and allowed to dry. During drying, the tissues shrink, and the central lumen "opens" and becomes more visible. Fusion of cotyledons in *Glaucoideae* is correlated with a germination syndrome in which a cotyledonary tube is formed that pushes the hypocotyl/epicotyl axis into the soil. The epicotyl later breaks through the wall of the cotyledonary tube as cell elongation and growth occur.

The relationships of *Q. glaucoides* to other members of subsection *Glaucoideae* are not clarified by examination of Trelease's series treatment of the oaks. Trelease (1924) erected series *Glaucoideae* and included in it four species in addition to *Q. glaucoides*. All four of these (*Q. baldoquinae* Trel., *Q. mixtecana* Trel., *Q. glaucophylla* V. Seem., and *Q. harmsiana* Trel.) are considered here to be synonyms of *Q. glaucoides*. Trelease placed three additional species in the associated series *Cancellatae* (*Q. cancellata* Trel., *Q. conjungens* Trel., and *Q. sororia* Liebm.). The first two of these species are clearly synonyms of *Q. glaucoides*. A difference of opinion exists regarding *Q. sororia*, which McVaugh (1974) placed as a doubtful synonym of *Q. splendens* Nee, and which treatment we follow here. Bello-G. and Labat (1987) considered *Q. sororia* a distinct species and did not mention *Q. splendens*, but cited under *Q. sororia* a collection (*Hinton 15081*) cited previously by McVaugh as *Q. splendens*. It is clear that the concepts of *Q. splendens* of McVaugh and *Q. sororia* of Bello-G. and Labat are equivalent. This species, which we refer to *Q. splendens*, is closely related to *Q. glaucoides* and is sympatric with it in some areas (see under *Q. glaucoides* below).

In addition to *Q. glaucoides*, several of the species in subsection *Glaucoideae* have prominently glaucous-blue waxy leaves (e.g., *Q. oblongifolia* Torr., *Q. engelmannii* Greene, *Q. splendens*, *Q. subspathulata* Trel., *Q. germana* S. & C., *Q. perpallida* Trel., *Q. depressipes* Trel.). The set of closest relatives of *Q. glaucoides* within subsection *Glaucoideae* probably include one or more of these species. A revised series treatment of species placed in subsection *Glaucoideae* and the relationship of *Q. glaucoides* to other species must await cladistic analyses of the whole group (Nixon, in prog.).

In addition to subsection *Glaucoideae*, fused cotyledons are found in subsection *Virentes* (Loudon) Camus (the southern live oak group). However, the relationship of subsection *Glaucoideae* to the live oaks remains uncertain at this time. Species of *Virentes* differ from *Glaucoideae* in trichome morphology, characters of the cupule, and certain characteristics of germination, and have a distribution that is centered in the southeastern United States and Caribbean. In contrast, no oak species referrable to subsection *Glaucoideae* are found east of the Edwards Plateau in the United States.

TAXONOMIC TREATMENT

KEY TO THE SPECIES

Leaves relatively thin, deciduous in winter; petioles (2-)5 – 12 mm long; leaf base rounded or cuneate, decurrent on petiole, occasionally somewhat cordate; fruit usually subsessile, the peduncle rarely if ever exceeding 1 cm in length; cupules saucer-shaped or shallowly cup-shaped, enclosing less than one third to one third of the nut, scales usually not strongly tuberculate; nut oblong or barrel-shaped, often flattened at both ends; cotyledons 2, entirely free, easily separable (sometimes adherent in dry material); anthers glabrous ..... 1. *Quercus laceyi*

Leaves coriaceous, persistent through winter, falling in spring or summer of following year; petioles 2 – 5 mm long, thick and expanded basally; leaf base cordate; peduncle of fruit variable in length, from subsessile to 4 – 6(-8) cm; cupule thick, hemisphaeric, enclosing one third or more of the nut, scales strongly tuberculate; nut usually globose, rounded distally; cotyledons marginally fused, appearing to be a single mass with a narrow central lumen that widens toward the base; anthers pilose ..... 2. *Quercus glaucoides*

1. **Quercus laceyi** Small, LACEY OAK (**Fig. 1**), Bull. Torrey Bot. Club 28: 358. 1901. *Quercus breviloba* Sarg. forma *laceyi* (Small) Trelease, Mem. Natl. Acad. Sci. 20: 102. 1924. *Quercus breviloba* subsp. *laceyi* (Small) A. Camus, Monogr. Genre *Quercus* 2:680. 1936-1938. TYPE: UNITED STATES: TEXAS: Kerr Co.: Lacey's Ranch near Kerrville, 1899-1901, *Howard Lacey s.n.* (NY!).

Quercus glaucoides of authors.

Trees to 5 – 8 (-10) m; bark light colored, papery or scaly; twigs at first pubescent with erect stellate trichomes, these soon deciduous, at maturity reddish and pruinose to tan and glabrous, 1.5 – 2 mm thick; lenticels scattered, white, usually not prominent; buds ovate to ovate-lanceolate, acute apically, 1.5 – 3 mm long by 1 – 2 mm diam.; bud scales brown with lighter margins, glabrous; stipules rarely persistent around terminal bud; immature leaves with dense vestiture of whitish erect stellate trichomes, these deciduous as the leaves expand; mature leaves thin, deciduous, glabrous, glaucous to yellowish-green, obovate or elliptic in outline, entire to shallowly lobed or occasionally deeply lobed, (2-)4 – 9(-21) cm long by (2-)3 – 6(-11) cm wide; petioles thin, gradually expanding toward base, (3-)5 – 9(-12) mm long; leaf bases cuneate and decurrent on petiole to rounded or rarely somewhat cordate; leaf tip broadly rounded, retuse; leaf margins thin, flat, not cartilaginous; leaf lobes if present oblong, squarish, often retuse; leaf teeth minutely mucronate; primary vein whitish or greenish, raised only on the abaxial surface, not prominently raised above; secondary veins 6 – 9 on each side, each terminating in a tooth or arching near the margins; tertiary veins irregularly percurrent; staminate catkins [pre-anthesis] 15 – 20 mm long; perigon deeply and irregularly cleft, sparsely pubescent externally, margins ciliate; stamens 3 – 4; anthers retuse, subsessile, ca. 0.7 mm long, glabrous; pistillate inflorescence to 1(-3) cm long, with 1 – 5 flowers concentrated distally; fruit annual, solitary or

FIG. 1. *Quercus laceyi*. Representative specimen: Coahuila, *Johnston et al. 12029* (NY).

paired, subsessile or on short peduncles to 1(-2) cm in the axils of the leaves; cupule saucer shaped or shallowly cup-shaped, enclosing one third or less of the nut, 10 – 12(-18) mm wide by 4 – 7 mm deep; cupule scales moderately tuberculate, tomentose with detachable hairs; nut oblong or barrel-shaped, often flattened at

both ends, (11-)13 – 15(-20) mm long by 9 – 11(-14) mm in diam.; cotyledons free, equal.

Distribution: Limestone hills, canyons and streamsides, the southern part of the Edwards Plateau of central Texas, southward in the mountainous areas of Coahuila and Nuevo Leon to the vicinity of Galeana and Pablillo, Nuevo Leon, Mexico. On the Edwards Plateau, the species occurs mostly at 350 – 600 meters elevation, while in Coahuila and Nuevo Leon, it typically occurs at much higher elevations, from 1500 – 2200 meters. *Quercus laceyi* may occur in Tamaulipas, but documented records are not known. Sometimes associated with remnant mesic forests which include *Acer grandidentatum* Nutt., *Tilia* spp., *Q. muhlenbergii* Engelm. and various pine and oak species.

Representative specimens: MEXICO: **Coahuila:** Mun. not recorded: Canyon Hundido, N side of Pico de Centinela, Sierra del Jardín, 1500 – 2250 m, 27 Jul 1973, *Johnston et al. 11777* (NY); Cañyon de la Gavia, S of Rancho de la Gavia, 1250 – 2200 m, 2 – 3 Aug 1973, *Johnston et al. 12029* (NY); Coahuila: middle part of Sierra San Marcos, 21 May 1983, *Marshall 83 – 17* (DAV); Sierra la Encantada, north base, 1200 m, 12 Jun 1984, 28° 37'N, 102° 17'W, *Wynd & Mueller 170* (BH-CHM, MO, NY); Bocatoche, N slope of Sierra del Oso, 2 Sep 1939, *Muller 3143* (BH-CHM); Mun. Cuatro Ciénegas: Sierra de la Madera: vicinity of "La Cueva" in Corte Blanco fork of Charretera Canyon; scrub-oak zone below the conifer-forests, 5300 – 6500 ft, 11 – 15 Sep 1941, *Johnston 8933* (BH-CHM); W side of Potrero de la Mula, about 20 km NW of Ocampo, on the escarpment near the mines, 18 Sep 1941, *Johnston 9207* (BH-CHM); in mid-Canyon de la Hacienda, ca. 35 (air) mi W of Cuatro Ciénegas, 5900 ft, 6 Aug 1973, 27° 04' N, 102° 25' W, *Henrickson & Wendt 11997* (DAV, TEX); upper Canyon del Pajarito, 6 Sep 1939, *Muller 3192* (BH-CHM); lower Cañón del Agua, 10 Sep 1939, *Muller 3267* (BH-CHM); N side, lower part of Canyon de la Hacienda, 1600 m, 11 May 1973, *Johnston et al. 10977* (NY); upper portion of Cañón de la Hacienda, below first lumber camp, ca. 22 (air) mi WNW of Cuatro Ciénegas, 5000 – 6000 ft, 28 Sep 1973, 27° 04' N, 102° 25' W, *Henrickson 13627* (DAV); Sierra de la Madera, NW of Cuatro Ciénegas, 1700 m, 24 May 1983, *Marshall 83 – 19* (DAV); Mun. General Cepeda: Sierra de Parras, near head of Cañón Domingo, 15 Jun 1965, *Muller 11217* (BH-CHM); Mun. Múzquiz: Hacienda Mariposa, ravine near Puerta Santa Ana, 22 Jun 1936, *F.L. Wynd and C.H. Mueller 230* (BH-CHM, MO, NY); Sierra del Puerto, Santa Ana, 23 Jun 1936, *Wynd & Mueller 262* (BH-CHM, MO, NY); Rancho Agua Dulce, E slope of the Sierra de San Miguel, 28 Jun 1936, *Wynd & Mueller 345. 346* (BH-CHM, NY); Sierra Hermosa de Santa Rosa, 5 mi S of Múzquiz, 2000 – 3000 ft, 8 Jul 1958, *Straw & Forman 1333* (BH-CHM, DAV); Cañón de las Trancas, Sierra Santa Rosa, 2000 SNM, 25 Oct 1951, *Correa 2220* (BH-CHM); Sorpresa Spring, 8 Jul 1936, *Marsh. Jr. 335* (BH-CHM); Sorpresa Spring, 9 Jul 1936, *Marsh, Jr. 344* (BH-CHM); La Cuesta del Plomo on the Múzquiz-Boquillas Hwy, 1750 – 1775 m, 14 Sep 1972, *Johnston, et al. 9225* (NY); Mun. Saltillo: San Lorenzo Canyon, mountains near Saltillo, 7000 ft, 12 Apr 1906, *Pringle 10228* (BH-CHM); Mun. Villa Acuña: Serranías del Burro, Rancho El Bonito, Cañón El Bonito, 29° 01' 30" N 102° 07' 30" W, ca. 1650 m, 17 Sep 1977, *Riskind & Valdes R. 2095* (BH-CHM, TEX); El Bonito, 12 air km W of Rcho. El Bonito HQ, near uppermost stock tank in Cañón El Bonito, 1625 m, 19 Sep 1977, 29° 01' 30" N 102° 07' 30" W, *Riskind. et al. 2200* (BH-CHM); Sierra del Carmen: Canyon de Sentenela [Centinela], Hacienda Piedra Blanca, 6 Jul 1936, *Wynd & Mueller 541* (BH-CHM, MO, NY), 8 Jul 1936, *Wynd & Mueller 617* (BH-CHM, MO, NY); canyon E of Mina Popo, ca. 12 (air) mi E of Boquillas, 29 Jul 1973, 29° 13' N, 102° 44' W, *Henrickson 11560* (DAV, TEX); Sierra del Pino: pine forest in Middle section of the Sierra, 2 – 10 mi N of camp at La Noria, 22 Aug 1940, *Johnston & Muller 559* (BH-CHM);

W ridge, west of camp at La Noria, 24 Aug 1940, *Johnston & Muller 616* (BH-CHM); Mun. not recorded: 12 km W of Hacienda de la Encantada, E side of the Sierra de los Guajes, Cañón de Milagro, 10 Sep 1941, *Stewart 1507* (BH-CHM); 12 km W of Hacienda de la Encantada, E side of the Sierra de los Guajes, Cañón de Milagro, 10 – 16 Sep 1941, *Stewart 1708* (BH-CHM). **Nuevo Leon:** 33 mi W of Linares, 5 mi W of San Pedro on Hwy 60, 5000 ft, 14 Jun 1972, *Breckon & Breckon 1287* (DAV); ca. 30 mi NE of Dr. Arroyo along Hwy 29 along the first pass, 6000 ft, 9 Sep 1971, 24° 02' N, 99° 58' W, *Henrickson 6617* (DAV); 6.6 mi S of La Escondida on Hwy 68, 5800 ft, 8 Dec 1966, *McIntyre & Gankin 278* (DAV); Linares-Galeana road, half way up the canyon, 3600 ft, 13 Jul 1953, *Manning & Manning 53292* (BH-CHM); 3 mi above Iturbide, on road to Galeana, in oak zone, 2000 m, 18 May 1949, *McVaugh 10561* (BH-CHM); mountains near Monterrey, 15 Jul 1933, *Mueller & Mueller 574* (BH-CHM); Mun. Galeana: Cañón San Francisco, Hacienda Pablillo, 31 Jul 1934, *Mueller & Mueller 1281* (BH-CHM); 23 mi E of Galeana on the Galeana-Linares Hwy, 25 Aug 1938, *Schneider 1119* (BH-CHM); 23 mi E of Galeana on the Galeana-Linares Hwy, 25 Aug 1938, *R.A. Schneider 1120* (BH-CHM); Puerto de Pastores, near Galeana, 5 Jul 1934, *Mueller & Mueller 1001, 1002, 1003* (BH-CHM); Alamar, Hacienda Pablillo, 20 Jul 1934, *Mueller & Mueller 1101* (BH-CHM); Alamar, Hacienda Pablillo, 23 Jul 1934, *Mueller & Mueller 1200* (BH-CHM); Cañón San Franciso, Hacienda Pablillo, 31 Jul 1934, *Mueller & Mueller 1282* (BH-CHM); Cañón San Francisco, Hac. Pablillo, 11 May 1934, *Mueller & Mueller 307* (BH-CHM); Taray, Hacienda Pablillo, 29 May 1934, *Mueller & Mueller 589, 590* (BH-CHM); Mun. Montemorelos: E slope of Sierra de la Cebolla, 21 Aug 1939, *Muller 2941* (BH-CHM); Mun. Villa Santiago: upper slopes of Cañón Guajuco, 14 Aug 1934, *Mueller & Mueller 1353* (BH-CHM).

U.S.A: TEXAS: **Bandera Co.:** Lost Maples State Park, N of Vanderpool, 9 Jun 1984, *L.E. Brown 7504* (BRIT/SMU); 9 mi W of Tarpley, Utopía to Bandera, just over fence N side of Hwy, 1600 ft, 13 Aug 1953, *Harris 289* (BH-CHM); Vanderpool, 11 Apr 1917, *Palmer 11535* (MO); Medina Lake, 14 Jun 1917, *Palmer 12264* (MO); Upper Seco Creek, 18 Jun 1916, *Palmer 10233* (MO). **Brewster Co.:** E Slope of Solitario Mt., canyon headers, 3800 ft, 20 Aug 1974, *Warnock 23860* (BH-CHM). **Edwards Co.:** 14.5 mi SE of Rocksprings, 9 Aug 1943, *V.L. Cory 42935* (BRIT/SMU); 10 mi SE of Rock Springs, 3 Apr 194-, *Muller 5155* (BH-CHM); 23 mi N of Brackettville on road to Rock Springs, 15 Jun 1945, *Muller 8086* (BH-CHM); 23 mi N of Brackettville on road to Rock Springs, 15 Jun 1945, *Muller 8087* (BH-CHM); Barksdale, 11 Oct 1916, *Palmer 10996* (MO); Nueces Rd., 11 Sep 1929, *Tharp s.n.* (MO). **Kendall Co.:** Rocky bluffs of Upper Cebelo River, near Boerne, 30 Sep 1917, *Palmer 12903* (MO, NY); Upper Cebelo Creek, 29 Sep 1916, *Palmer 10863* (MO). **Kerr Co.:** ca. 14 mi W of Kerrville, Turtle creek, 29 Sep 1946, *V.L. Cory 52407* (BRIT/SMU, NY); Kerrville, rocky bluffs of Guadalupe River, 7 May 1928, *Palmer 33796* (MO, NY, TEX); 2 mi SE of Mountain Home, 16 mi NW of Kerrville, near the E bank of the Guadalupe River, 5 Jun 1942, *Muller 5022* (BH-CHM); W bank of Guadalupe River at Ingram, 7 mi NW of Kerrville, 5 Jun 1942, *Muller 5021* (BH-CHM); Kerrville, 2 Oct 1916, *Palmer 10884* (MO); Lacey's Ranch, 28 Mar 1916, *Palmer 9284:* 3 Oct 1916, *Palmer 10889* (MO). **Kimble Co.:** South Llano River, Telegraph, 9 Oct 1916, *Palmer 10952* (MO). **Medina Co.:** Medina Dam, Oct 1938, *Parks s.n.* (DAV). **Menard Co.:** Menard, 12 May 1917, *Palmer 11895* (MO). **Real Co.:** ca 11 mi N of Hackberry, 10 Jul 1943, *Cory 42619* (NY); 17 mi W of Camp Wood, 2000 ft, 19 Jun 1953, *V.M. Harris 24* (BH-CHM); 13 mi E of Camp Wood, on Hwy between Camp Wood and Leakey, 2000 ft, 21 Jul 1953, *Harris 172* (BH-CHM); 3 mi SE Camp Wood, Z. B. Gray Ranch, 1500 ft, 24 Jun 1953, *Harris 55* (BH-CHM); Barksdale, 7 May 1918, *Palmer 13516* (MO); Leakey, 10 Jun 1916, *Palmer 10152* (MO). **Terrell Co.:** 16 mi S of Sheffield, in Little Horse Head Canyon, Blackstone Ranch, 27 Jun 1949, *Webster 429* (BH-CHM); 16 mi S of Sheffield, in Little Horse Head Canyon, Blackstone Ranch, 27 Jun 1949, *Webster 431* (BH-CHM). **Uvalde Co.:** 6 mi S Montell, Y.A. Coleman Ranch, 1250 ft, 23 Jul 1953, *Harris 177* (BH-CHM); 6 mi S of Montell, Y.A. Colemannders, just over fence N side of

Hwy, 1250 ft, 24 Jun 1953, *Harris 43* (BH-CHM); 8 mi N of Uvalde, the Dry Frio River, 27 Jun 1942, *Muller 5045* (BH-CHM); valley of the Dry Frio River, 8 mi N of Uvalde, 27 Jun 1942, *Muller 5054A* (BH-CHM); Uvalde, 14 Oct 1916, *Palmer 11042* (MO); Concan, 14 Jun 1916, *Palmer 10187* (MO); Without county data: W Fork of Nueces River, Oct 1883, *Havard 4* (BRIT/SMU, MO).

2. **Quercus glaucoides** Mart. & Gal. (**Fig. 2**), Bull. Acad. Brux. 10(1):209. 1843. TYPE: MEXICO. Oaxaca: Mixteca Alta, 2600 m, Jun 1840, *Galeotti 103* [*Schiede 103*] (HOLOTYPE: BR!; ISOTYPES: C!, G-DC!, K!).

Quercus cordata Mart. & Gal., Bull. Acad. Brux. 10(1):211. 1843. TYPE: MÉXICO: OAXACA: Mixteca Alta, Galeotti 111 (Type specimen lost, fide Trelease, 1924:53; subsequent search has been unsuccessful). *Q. cordata* has long been considered a synonym of *Q. glaucoides*. The protologue of *Q. cordata* is consistent in locality and description with the holotype of *Q. glaucoides*, which we select as neotype for this name. NEOTYPE here chosen: MÉXICO. OAXACA: Mixteca Alta, 2600 m, Jun 1840, *Galeotti 103* [*Schiede 103*] (HOLOTYPE: BR!; ISOTYPES: C!, G-DC!, K!).

Quercus glaucophylla v. Seem., Bot. Jahrb. 29:95. 1900. TYPE: MÉXICO. OAXACA: Sierra de San Felipe, 27 Aug 1895, *Pringle 4843* (HOLOTYPE: BR!; ISOTYPE: BM!, G!; K!, BH-CHM[ex G]!).

Quercus baldoquinae Trelease, Mem. Natl. Acad. Sci. 20:53. pl. 43. 1924. TYPE: MÉXICO. MICHOACAN: Cerro Baldoquin, *Endlich 1354* (HOLOTYPE: B, presumed destroyed). Trelease cited only the single specimen, and Endlich material apparently was not distributed to other herbaria. LECTOTYPE here chosen: Trelease's original plate 43.

Quercus cancellata Trelease, Mem. Natl. Acad. Sci. 20:55. pl. 49a, 49b. 1924. TYPE: MÉXICO. PUEBLA: Sierra de Mixteca, 24 Aug 1908, *Schenck 236* (HOLOTYPE: B, presumed destroyed). The single paratype cited, *Schenck 92*, the basis of plate 49b, was also at *B* and was similarly destroyed. Duplicates of *Schenck* collections are not known. LECTOTYPE here chosen: Trelease's original plate 49a.

Quercus conjungens Trelease, Mem. Natl. Acad. Sci. 20:55. pl. 48a, 48b. 1924. TYPE: MÉXICO. GUANAJUATO: Acambaro, at 1900 m, 6 Oct 1904, *Pringle 8841* (HOLOTYPE: B, presumed destroyed; LECTOTYPE here chosen: G-BOISS!; ISOTYPES: BH-CHM![ex G], M!, K!, TEX!).

Quercus mixtecana Trelease, Mem. Natl. Acad. Sci. 20:54. pl. 46. 1924. TYPE: MÉXICO. PUEBLA: Sierra de Mixteca, San Luis, 16 Aug 1908, *Schenck 235* (HOLOTYPE: B, presumed destroyed). As with *Q. cancellata*, no extant Schenck collections are known, and no other specimens were cited. LECTOTYPE here chosen: Trelease's original plate 46.

Trees to 10 m, usually less than 5 m tall, bark scaly and gray or sometimes darker and deeply furrowed; twigs 1 – 2 mm thick, yellowish-tomentulose when very young, soon glabrous, gray to reddish brown, with numerous small round whitish corky lenticels; buds 2 – 4 mm long, ovoid or rounded, dark brown; bud scales glabrous, with waxy or ciliate margins; stipules linear-subulate, 6 – 9 mm long, pilose, deciduous or occasionally persistent around terminal buds; immature leaves reddish, clothed with yellowish curly fasiculate trichomes that are soon deciduous as the leaves expand; mature leaves coriaceous, thick, glaucous green, persisting a full year, oblanceolate to oblong, elliptic or obovate, (4-)6 – 12(-15) cm long, 2.5 – 5(-8) cm wide, 2 – 2.5 times as long as wide; petioles 2 – 6 mm long, 1 – 2.5 mm thick at the abruptly swollen base, reddish with a waxy pruinose bloom; leaf base cordate or occasionally rounded; leaf tip rounded,

FIG. 2. *Quercus glaucoides*. Representative specimen: Guerrero, *Hinton et al. 9051* (NY).

sometimes broadly retuse; leaf margins cartilaginous, not revolute, usually undulate, entire or with 1 – 7 broad, often antrorse teeth on each side; leaf teeth each with a darkened callous or "glandular" thickening terminating the secondary vein; primary vein straight, prominent and yellowish, raised on adaxial and abaxial surface of the blade at least toward base; secondary veins 6 – 12 on each side, each terminating in tooth or arching near the margin and eventually

anastomosing with next distal secondary vein; tertiary veins percurrent, arched and sometimes branched; staminate catkins 2 – 3 cm long, densely hairy; anthers pilose, 1 – 1.6 mm long. Pistillate inflorescence to 1 – 8 (-20) cm long, with 2 – 3 (-8) flowers, these often scattered along rachis; fruit annual, solitary or 2 – 3, subsessile in the leaf axil or more often on a peduncle 1 – 6 cm long; cupule turbinate or hemispheric, 12 – 18 mm wide, the scales brownish or yellowish tomentulose, often prominently tuberculate except near the rim of the cupule; nut ovoid or oblong-barrel-shaped, 12 – 18 mm long, one third to one half included; cotyledons marginally fused, the free central lumen wider toward the base of the seed.

Distribution: A widespread and common species, often on limestone, at 1000 – 3000 meters elevation, in dry tropical deciduous forest, dry oak woodland, dry pine-oak forest and margins of thorn scrub in Guerrero, Hidalgo, Jalisco, Mexico, Michoacan, Nayarit, Oaxaca, Puebla, San Luis Potosi, Sinaloa, and Zacatecas. Not known to overlap in range with *Q. laceyi*.

Quercus glaucoides apparently hybridizes in nature with few other species of oak. Morphologically intermediate specimens between *Q. glaucoides* and *Q. splendens* Nee, as well as *Q. pedunculariss* Nee, have been noted, but are not common.

Representative specimens: MEXICO. Estado unknown: *Liebmann 105=3489* (BH-CHM). GUERRERO. **District Of Mina:** Los Barrales, 4 Jul 1939, *Hinton et al. 14393* (NY); Placeres, 6 Jul 1936, *Hinton et al. 9051* (NY); Parotas, 1260 m, 5 Aug 1936, *Hinton et al. 9198* (NY); Cerro de la Mesa, Coyuca de la C. Gro., Nov 1951, *García 2179* (BH-CHM); Chilpancingo, Jalapa, km 13.5 en carretera a Chichihualco, 1560 m, 30 May 1968, *Kruse 1815, 1816* (BH-CHM); Mazatlán, falda este del cerro El Alquitrán, 1380 m, 16 Jun 1968, *Kruse 1849* (BH-CHM); Chilpancingo, Jalapa, km 13.5 en carretera a Chichihualco, 18 Jul 1968, *Kruse 1888, 1889* (BH-CHM); Chilpancingo, Jalapa, km 13.5 en carretera a Chichihualco, 1480 m, 6 Oct 1968, *Kruse 2012* (BH-CHM); 3 km NE of Huajojutla, 13 km NE of Taxco, 12 Oct 1951, *Muller 9157, 9158, 9159* (BH-CHM); Cerro Tres Piedras, Cutramalia, 8 Oct 1951, *Narciso Santamaría 2180* (BH-CHM); Cerro de la Mesa, Coyuca de la C. Gro., Nov 1951, *Tabares 2183* (BH-CHM). HIDALGO: Mun. Pachuca: SE of Epazoyucan, 2500 – 2700 m, 14 Jun 1947, *Moore 3058* (BH, BH-CHM); JALISCO: 20 – 25 mi NNW of Guadalajara, between Milpillas and Escalón, near summits of hills falling off into barranca of Río Grande, 12 Apr 1951, *McVaugh 11970* (BH-CHM); Cerro de García, Tuxcueca, 8 mts y 1,570 mts, 2 Aug 1951, *Jose León Navarri 2060* (BH-CHM); 1 km al E de Mata de Bule, cerca de Los Corales, 25 Oct 1963, *Rzedowski s.n.* (BH-CHM); Mun. Tecalitlan: Barranca de San Juan de Dios, cerca de Los Corales, 1300 m, 23 Oct 1963, *Rzedowski 17373* (BH-CHM); 1 km al E de Mata de Bule, cerca de Los Corales, 1200 m, 25 Oct 1963, *Rzedowski 17484* (BH-CHM). ESTADO DE MEXICO. **District of Temascaltepec:** Tejupilco, 7 Sep 1934, *Hinton 6561* (NY); Mun. Valle de Bravo: Pine-oak forest between Tiloxtoc and San Bartolo, NW of Valle de Bravo, 26 Sep 1951, *Muller 9098* (BH-CHM, NY); 1 km S of Chalma, 23 Oct 1951, *Muller 9219* (BH-CHM); Cerro de Moctezuma, Los Remedios, Naucalpán, 2 Nov 1951, *Rodríguez 2145, 2251, 2252* (BH-CHM). MICHOACÁN. **Zitacuaro-**Coyota, 25 Aug 1938, *Hinton et al. 13099* (NY); slopes of Cerro Potrerillos, ca. 5 mi N of Cotija and 22 mi S of Jiquilpán, 5 – 9 Oct 1961, *King & Soderstrom 4655* (NY); W slopes of Cerro de Carboneras, ca. 22 km S of Utruapán, 3300 – 3700 ft, 16 – 22 Oct 1961, *King & Soderstrom 4914* (NY); 12 km W of Zamora, at lower limit of oaks, 19 Sep 1951, *Muller 9061* (BH-CHM); 2 km al SE de Palo Alto, 22 Mar 1963, *Rzedowski 16333* (BH-CHM); Mun. Cojumatlán: 2 km al SE

de Palo Alto, 1600 m, 22 Mar 1963, *Rzedowski s.n.* (BH-CHM). MORELOS. Noroeste de Cuernavaca km 85 carretera Cuernavaca-Tepoztlanco, 1730 m, 5 May 1965, *Palácios 12* (BH-CHM); 8 km al Noroeste de Cuernavaca km 8 carretera Cuernavaca-Tepoztlanco, 1750 m, 5 May 1965, *Palácios 2* (BH-CHM). OAXACA. Canyon of the Río Zavaleta near San Pablo Quatro Venados, 15 – 18 km WSW of Oaxaca, 20 – 25 Jan 1937, *Camp 2549* (NY); Sierra de San Felipe, 6000 ft, 27 Aug 1894, C.G. *Pringle 4843* (NY); 4 km SW of Magdalena Jicotlan, district of Coixtlahuaca, 2300 m, 17 May 1968, *Rzedowski 25715* (NY); Near San Juan del Estado, Oaxaca Valley, 7 Nov 1894, *Smith 779* (NY); Río Flor, S Pedro Jilotepec, 1000 m, 29 Oct 1952, *MacDougall 2424* (BH-CHM); Río Flor, S Pedro Jilotepec, 28 Oct 1952, *MacDougall 2426* (BH-CHM); Tenango, 3000 m, 30 Oct 1952, *MacDougall 2430* (BH-CHM); Montaña en el camino a Chilapa de Matamoros, 2000 mts, 1 Apr 1953, *Matuda 28421* (BH-CHM); 10 km NW of Tamazulapán, in the Mixteca Alta, Cerro Encinal above Santa María de Tutla, 23 Nov 1951, *Muller 9395* (BH-CHM); 6 km NW of Huitzo, 42 km NW of Oaxaca, in the Mixteca Alta., 23 Nov 1951, *Muller 9412* (BH-CHM); 4 km above and SE of Matatlan, 25 Nov 1951, *Muller 9414* (BH-CHM); 7 km E of El Camarón, 25 Nov 1951, *Muller 9416, 9417* (BH-CHM); 7 km SE of Portillo de Nejapa, 18 km SE of Camarón, 2 Dec 1951, *Muller 9457* (BH-CHM); foothills of Sierra de San Felipe, 3 km NE of San Juan del Estado, 25 km NW of Oaxaca, 3 Dec 1951, *Muller 9461* (BH-CHM). PUEBLA. Cerro de Gavilán, 7000 – 8000 ft, Aug 1909, *Purpus 4090* (NY); Zapotitlán Valley, between Calipa and Acatepec, 1200 to 2000 m, 20 Jul 1961, *Smith et al. 3994* (NY); 3 km NNW of Tepenene, 15 km SSE of Izúcar de Matamoros, 22 Nov 1951, *Muller 9385* (BH-CHM); 10 km SSE of Las Peñas, 16 km NNW of Acatlán, 22 Nov 1951, *Muller 9386* (BH-CHM); 4 km SE of Chila, 4 km NW of Oaxaca state line, 22 Nov 1951, *Muller 9389* (BH-CHM); Valle de Bravo: 3 km N of Santo Tomás de los Plátanos, edge of the Tierra Caliente, 1400 m, 25 Sep 1951, *Muller 9083* (BH-CHM).

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BOOK REVIEWS

HOBBELINK, HENK. 1991. **Biotechnology and the Future of World Agriculture.** (ISBN: 0-86232-837-3 Paper; 0-86232-836-5 Cloth). +159 pp. (Humanities Press International, 165 First Avenue, Atlantic Highlands, NJ 07716; (908)-872-1441). Price: $49.95 Cloth; $15.00 Paper.

This book promotes the field of biotechnology and how it affects world agriculture especially in developing countries. Contents: The Fourth Resource, Agriculture in Crisis, The Tools, The Actors, Providing inputs, Transforming output, Controlling the Profit, Appropriate Biotechnology? The Biotechnologist, Epilogue and Index. This book is a must for any one interested in Biotechnology. *Krishna Puttaparthi.*

SALUNKHE, D.K., S.S. DESHPANDE. 1991. **Foods of Plant Origin**. Van Nostrand Reinhol, 115 Fifth Avenue, New York, NY 10003. Price: $83.95. 501 pp.

This book is the most extensive and referenced listing of Food Plants, their Production, Technology and Human Nutrition., chapter 1: Cereals: It covers their production, distribution, origin and botanical classification, agronomy, breeding, processing and products. Chapter 2: Describes Legumes, their origin, diversity, nitrogen fixation, weed control, drying, storage, processing and utilization. Chapter 3: Fruits and Vegetables their introduction and production history. Chapter 4: Sugar crops, their introduction, history of sugar development, sources and consumption. Crop nutrition and fertilization, cultural operation, maturation and ripening, harvesting, loading, transport, storage and utilization of sugar industry by-products. The index is alphabetically arranged. This book would be an excellent source for researchers in agriculture, nutritionists, plant geneticists, agricultural extension workers and government agents. *Krishna Puttaparthi.*

AGRICULTURE CANADA. 1991. **Poisonous Plants of Canada**. (ISBN: 0-660-13467-5) 96 pp. (International Specialized Book Services, 5602 N.E. Hassalo Street, Portland OR 97213-3640). Price: $10.75 paper.

Publication contains the native and cultivated plants of Canada that are poisonous to humans and animals. Contents: Introduction, Alphabetical listing by Botanical names. Appendix 1: Canadian plants poisonous to humans, Appendix 2: Canadian plants poisonous to animals, bibliography, index to common names, index to botanical names. *Krishna Puttaparthi.*

SPOERKE, DAIVD G. 1990. **Herbal Medications**. Woodbridge Press, P.O. Box 6189, Santa Barbara, CA 93160. 192 pp.

This book provides information about more than 200 herbs, their uses, active principles, mode of action and their adverse effects. Contents: Introduction, Glossary of terms, References, Index and Monographs. Each Herb monograph is divided into six sections. The first section states the common name and species name of each herb. The second section lists the common active ingredients. Section three discusses the mechanisms of action for each plant. Fourth section describes the alleged uses for each plant. The fifth section describes the adverse effects or poisonings. The last section discusses the specific comments regarding the herb. This text is a good reference for any one interested in using the herbs for medication. *Krishna Puttaparthi.*

THE REEVALUATION OF *PORTULACA PILOSA* AND *P. MUNDULA* (PORTULACACEAE)

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ABSTRACT

The relationship between *Portulaca pilosa* L. and *P. mundula* I.M. Johnston has been reevaluated. Herbarium and live material from Mexico, the Caribbean and the United States were analyzed and the results were correlated with chromosome numbers from the same regions. No consistent morphological characters permit the separation of the two taxa when the entire geographical range is considered. The conclusion again, is that the correct name for the species is *P. pilosa* L., with *P. mundula* I.M. Johnston as a synonym.

RESUMEN

La relacíon entre *Portulaca pilosa* L. y *P.mundula* I.M. Johnston a sido reevaluada. Materiel de herbario y materiel vivo de Mexico, el Caribe y 105 Estados Unidos de America fueron analizados y los resultados correlasionados con el numero de cromosomas de las misma regiones. Ningun característico morfologico compatible con la separacion de Los dos taxos pudo ser determinado cuando la region geográphica entera fue considerada. La conclucion otra vez, es que para nombrar la especie correctament se usa *P. pilosa* L. y que *P. mundula* I.M. Johnston es sinónimo.

INTRODUCTION

Preparation of the treatment for the genus *Portulaca* for the Vascular Flora of the Southeastern United States required an analysis of plants referred to as *P. pilosa* L. and *P. mundula* I.M. Johnston (Matthews and Levins 1985a, b). Over 700 specimens from 36 herbaria were examined. SEM's of seed surfaces were combined with morphological data to reach the taxonomic decisions. An expansion of this southeastern treatment for Flora of North America project has included chromosome studies, observations on living material and an expanded analysis of herbarium specimens from the southwest and west United States, Central America and the Caribbean. These additional data, when combined with more information regarding the type specimen of *P. pilosa,* have led to a reevaluation and further substantiation of the synonymy of *P. pilosa* and *P. mundula.*

MATERIALS AND METHODS

Herbarium specimens were borrowed from the following institutions for the new examination: ARIZ, ASC, ASU, BRY, CAS, COLO, DAV, DES, DUR,

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HPC, ISC, JEPS, KANU, KSC, KSP, LA, MICH, MNA, MU, NMC, OKL, OKLA, PAUH, RSA(POM), SD, SRSC, TAI, TAES, TAMU, UC, UCSB, UNLV, UNM, UT, UTC, UTEP, UVST. Specimens from the previous study were reexamined from: A, FLAS, FSU, G, LL, MO, NY, SMU, TEX, UNCC, US, and USF. Live material gas studied from Ouintana Roo, Yucatan; Collier and Lee Cos., FL; Lee Co., AL; Crisp Co., GA; Beaufort Co., SC; Wilson Co., TN; Benton Co., AR; Cimarron Co., OK; Brewster, Colorado, Hidalgo, Jeff Davis, Kinney and Uvalde cos., TX; Luna Co., NM. Voucher specimens for morphological and cytological verification are deposited at UNCC.

Root tip chromosomes were obtained from stem cuttings. Chemical stimulants (e.g. Rootone) when applied to the stem cuttings to induce root tip growth produced polyploid cells. These stimulants were not used. Root tips were excised into 0.1% colchicine for 1.5 hrs, fixed in 3:1 alcohol-acetic acid overnight, hydrolyzed in IN HCl for 12-15 min at 60° C, placed in Feulgen for four hrs and squashed in a dilute Aceto-carmine stain to provide cellular detail. At least 20 root tips and a minimum of 10 metaphase figures were counted to validate the number for each population. Photographs were taken using a Zeiss Axioskop equipped with Nomarski differential interference contrast optics.

Several statistical tests were performed. For each character, a one-way analysis of variance was used to test for significant differences among the means for all populations. Tukey's unplanned comparisons also were used as *a posteriori* tests for the significance of differences in the means for all population pairs. A multivariate discriminant analysis (Blackith and Reyment 1971) was also performed on these data using the DISCRIM program of SAS (SAS 1985). In this analysis a discriminant function is generated, using both variables, which attempts to classify each of the groups (e.g. populations). The percentage of correct "classification" is indicative of the power of this discriminant function.

MORPHOLOGY

Matthews and Levins (1985a) provided a statistical comparison of the following morphological characters that had been used by Johnston (1948) to define *P. mundula* pedicel length, capsule diameter, and seed diameter. Their results showed no significant difference for these characters for plants from FL, AL, MS, LA, AR, TX, OK, including 23 of Johnston's paratypes. An SEM analysis of seed surfaces showed that a specific seed surface pattern could not be used to separate the two taxa or to define the geographically separate populations within this red/purple flowered species.

For our new analysis, specimens were borrowed from 36 herbaria that were not sampled in the study by Matthews and Levins (1985a). An additional 280 specimens from the United States and Mexico and 10 specimens from Honduras, Cuba, Dominican Republic, Puerto Rico, and Haiti were examined. We found no readily definable differences in these specimens from the 700 examined

previously. The specimens from Central America and the Caribbean had larger capsules, stipes and seeds, but were well within the range of measurements given by Legrand (1962) for *P. pilosa.*

Since no Caribbean specimens were included in the study in 1985, measurements were made on Caribbean specimens and these measurements were combined with the original data to again compare pedicel lengths and capsule diameters (Table 1). The Caribbean specimens had the shortest pedicels, but there is overlap with the other population means, including Johnston's paratypes. The fact that the Alabama population was not significantly different is due to the small sample size for Alabama. For capsule comparisons, the picture is more complex. Johnston's paratypes group with the smaller capsules from Arkansas and Oklahoma, but with the overlap do not form a group that can be separated from capsules of the Caribbean, Texas and the remainder of the southeastern U.S.

Pedicel length and capsule diameter have been the two most commonly used measurements to define *P. mundula*. It is apparent that a univariate analysis does not support the use of these characters. To determine if these characters functioned together, a discriminant analysis was performed on pedicel length and capsule diameter on these 11 populations, as described above. It yielded misclassification percentages as follows: AL-83%, AR-50%, CAR-55%, FL-92%, JP-78%, LA-82%, MS-80%, OK-94%, TX-CP-81%, TX-HP-94%, TX-TP-74%. The misclassification (e.g. error in correctly classifying the populations based on these two characters together) was high. The discriminant function performed very poorly in separating these 11 populations.

There has been no confusion regarding the color of the petals in *P. pilosa* L. and *P. mundula* Johnston, both being red/purple. Flower color is not mentioned by Linnaeus (1753), but he references Herman (1705) and Commelin (1697), both of whom cite red/purple flowers, confirm this color for *P. pilosa.* In our examination of herbarium specimens, we occasionally found a specimen noted as having yellow flowers. In the specimens from the southwest, this often was an error in identification with the southwestern yellow-flowered species, known as *P. parvula* Gray (Correll and Johnston 1970) or as *P. halimoides* L. (Legrand 1962 and Kelley 1989). In the dried condition (e.g. lacking evident petal color) *P. halimoides* can be identified by its characteristically compact stellate, non tuberculate, seed surface. From the southeastern specimens we found only one collection noted as having yellow flowers. The seed surface was typical of *P. pilosa.* Three specimens were available. The exact data on the label are cited below: South Carolina. Beaufort Co.: W side of Lemon Island on S side of SC route 170, just W of Chechasee River. Elevation ca 1-2 m Forest of *Sabal palmetto-Pinus elliotti-P. taeda* with *Sabal minor* and *Serenoa repens.* Sandy roadside. Flowers yellow, 12 Sep 1982, *D.E. Boufford, B. Bartholomew and S.A. Spongberg 23099* (A! KANU! MO!). We have visited this site three times to search for yellow-flowered plants, but have found only those with red/ purple flowers. We have attempted to germinate seeds

TABLE 1. Comparison of pedicel lengths and capsule diameters for Alabama (AL), Arkansas (AR), Caribbean (CAR), Florida (FL), Louisiana (LA), Mississippi (MS), Oklahoma (OK), Texas coastal plain (TX-CP), Texas high prairie (TX-HP), Texas Trans-Pecos (TX-TP), and Johnston's Paratypes (JP). Means connected by lines are not significantly different at the 0.05 level. (However, because of small sample sizes, some anomalous gaps occur in the extremes of the comparison.)

PEDICELS

Pop:	CAR	AR	TX-HP	LA	MS	OK	JP	FL	TX-TP	TX-CP	AL
X	0.350	0.363	0.429	0.441	0.453	0.500	0.539	0.595	0.605	0.613	0.616
SD	0.150	0.226	0.199	0.176	0.164	0.262	0.229	0.220	0.250	0.225	0.147
N	18	8	17	17	15	17	23	38	19	16	6

CAPSULES

Pop:	AR	OK	JP	LA	TX-HP	CAR	TX-TP	MS	FL	AL	TX-CP
X	1.875	1.924	1.965	2.212	2.336	2.400	2.426	2.447	2.518	2.600	2.619
SD	0.276	0.284	0.182	0.344	0.324	0.616	0.238	0.292	0.364	0.310	0.421
N	8	17	23	17	17	18	19	15	38	6	16

from these three specimens, but without success. Hence, we cannot explain this notation of yellow flowers. However, we are confident that the red/purple flower color is consistent for *P. pilosa (P. mundula).*

Portulaca pilosa (P. mundula) consistently has hairs in the leaf axils and in the inflorescence. The length and density of hairs appears to be directly related to the heat and moisture levels during the growth of the plant. Plants that are extremely woolly in appearance have dense, long axillary hairs and short internodes so that the stem appears to be covered with hairs (Figs. 5 & 6). Growth conditions producing less dense, shorter hairs and more widely spaced internodes produce plants that appear less woolly. The same plant may exhibit both conditions. A densely woolly specimen of *P. pilosa* was collected in the desert south of Alamogordo, NM and returned to the greenhouse in NC where it continued to grow. The new branches had shorter hairs and longer internodes and the stem was less woolly. This same progression from woolly to nonwoolly was noted in the following specimen. The exact data on the label are cited below: Texas. Val Verde Co.: Rocky hillside, 14 mi S of Juno near Devils River, Rt 163. Collected 11 Oct 1975 when senescent. Subsequent growth to flowering in greenhouse. Tuberous rooted, cleistogamous, 22 Jan 1976, *W.W. Brown s.n.* (TEX!). The cleistogamous situation would result from the winter growing conditions. In our study of herbarium specimens, we checked for any correlation between the density of hairs and the pattern of the seed surface. No correlation was found. As to the variation in the pattern of seed surfaces for the red/purple flowered species, Matthews and Levins (1985a) presented SEM's of 22 surfaces found on plants collected from FL to TX. They concluded that there was an overall trend of flattened roughenings and fewer tubercles toward the north and west of the range of distribution, with most variation in the southwest part of Texas (Trans-Pecos). Seed surface pattern could not be used exclusively to define *P. pilosa*. In this analysis an unusual suite of specimens was found during the seed surface reevaluation. Three herbarium sheets were compared. The exact label data are cited below: Texas. Ward Co.: About water-filled quarries in mesquite-creosote bush formation, 5.5 mi E of Barstow. Flowers rose-pink. 11 Sep 1965, *D.S. Correll 31691* (LL! SMU! UC!) Each sheet had three specimens, and the assumption would be that these nine specimens represent a sample of the same population. The seed surface patterns present were all S-undulate (stellate), but with the following variation in tubercles: very smooth, and no tubercles; raised surfaces and slight tubercles; sharply tuberculate. These correspond to the SEM's of Matthews and Levins (1985b) as Figs. 22, 21 and 19 respectively. The sheet from LL has one specimen with smooth surfaces, one with raised surfaces and one strongly tuberculate. The sheet from SMU has two specimens with smooth surfaces and one with raised surfaces. The UC sheet has two specimens with smooth and one with raised surfaces. In some species of *Portulaca* the pattern of the seed surfaces is more predictable and species specific. This is true for *P. umbraticola* Kunth, where none

PORTVLACA CVRASSAVICA PROCVMBENS

FIG. 1. Illustration of *Portulaca pilosa* L. as interpreted by Commelin, 1697.

FIG. 2. Illustration of *Portulaca pilosa* L. as interpreted by Herman, 1705.

FIG. 3. Progressive growth of *Portulaca pilosa* L., showing large, hemispherical leaves on the primary stem and small, terete leaves on the lateral branches.

of the three subspecies varies in the pattern of the seed surfaces (Matthews et al. 1992). In another species, *P. biloba* Urban, the pattern of seed surfaces is usually predictable, but some variation can be found (Matthews et al. 1991).

Growth habit is another morphological trait that appears to vary with tropical and temperate habitat. Plants in the tropics are more prostrate while those in temperate regions are suberect to erect. Tropical plants transplanted to the greenhouse in North Carolina produced more upright lateral shoots than prostrate lateral growth.

Johnston (1948) made the following statement regarding the morphological definition of *P. pilosa* vs *P. mundula.* "The name *P. pilosa* L., Sp. PI. 445 (1753) is ultimately based on plants originating on the island of Curacao, in the Dutch West Indies off the north coast of Venezuela. Linnaeus founded his species on descriptions and illustrations given in the published works of Royen, Commelin, Herman and Plukenet. These authors treated plants, cultivated in the gardens at Amsterdam and Leiden, said to have originated in Curacao. The illustrations and comments by Commelin, Hort. Med. Amstelodam. 9, t.5 (1697), and Herman, Par. Batavus 215 cum fig. (1705), are especially complete and clear and leave little doubt as to the identity of the plant properly called *P. pilosa* L." Matthews and Levins (1985a) said: "When Johnston formulated the idea of *P. mundula* he stated that he had taken his concept of *P. pilosa* from pictures portraying the Linnaean

taxon, but there is no indication that he examined any specimens of *P. pilosa* outside of the southwestern U.S. It would be difficult, in our opinion, to develop a concept of variability of a taxon as widespread as *P. pilosa* from pictures, particularly those as stylized as Commelin's and Herman's." Figure 1 is a photograph of the Commelin plate and Figure 2 of the Herman plate. Herman notes that the tops of the leaves are flat, Commelin makes no such reference. Observations on plants grown under cultivated conditions (as would be the case in gardens in Amsterdam and Leiden) show that the leaves are often hemispherical (flat on top) instead of terete. Further observations on plants grown in our greenhouse have shown that the leaves on the primary stem are large and often hemispherical, while the leaves on lateral branches are usually smaller and more terete (Fig. 3). Plants in the wild, under dry conditions, typical of Portulaca habitat have larger leaves initially but during the branching growth period the new leaves are smaller and more terete. In the tropical habitats, where droughts are less severe, the plants retain the larger leaves and the new growth has larger leaves. In temperate habitats, particularly in the deserts of the southwestern U.S. and in Mexican deserts where drought is often the situation, the larger leaves will abscise and the new growth will be smaller. Plants grown in a garden, as in Amsterdam and Leiden, would be expected to exhibit the larger, hemispherical leaves. This factor may have influenced the drawings of Commelin and Herman.

Johnston (1948) does not provide any insight as to whether he sought information from the Linnaean collection. We were able to obtain a photograph of specimen 625.2 LINN, the specimen attached to the name *P. pilosa* L. (Fig.4). This specimen is the lectotype, designated as "type" by Geesink (1969). We compared this lectotype to present day specimens. Figures 5, 6, 7 and 8 show, respectively, the type of *P. mundula* Johnston, a specimen of *P. pilosa* from Florida, and two specimens from the paratypes cited by Johnston as representing *P. mundula*. Comparison of Johnston's type and the paratypes (Figs. 4, 7 & 8) and then the specimen from FL (Fig. 6) with the type (Fig. 5) illustrates the wide range of morphological variability present in *P. pilosa* in the United States and Central America. Note that the less woolly specimens (Figs. 7 & 8) were collected at high altitude or northern latitude, representing cooler habitats.

CYTOLOGY

Steiner (1944) reported the chromosome number for *P. pilosa* as $2n = 16$. His plants were collected in Florida. Subsequent counts for this species have been by Diers (1961) $2n = 18$, Hsu (1968) $2n = 36$, Mi-i and Iwasa (1972) $2n = 16$, Kim and Carr (1990) $2n = 16$. Diers' specimen was from near Cochabamba, Bolivia, an area of 8,000 + feet altitude with a mild yearly climate. Legrand (1962) does not list any specimens of *P. pilosa* from Bolivia, nor does he indicate that the geographical distribution of this species extends into Bolivia. Hsu's specimen was from the coastal area of Taiwan. Pingtung Co.: littoral habitat, 5 Oct 1967, *C.C.*

FIG. 4. Lectotype of *Portulaca pilosa* L. from the Linnaean collection.

Hsu 4210 (TAI!). This specimen is pilose, the leaves are lanceolate and may be terete. The label notes yellow petals and the seed surface is non-stellate, unlike any pattern we have observed in *P. pilosa* in the western hemisphere. The report by Mi-i and Iwasa (1971) of $2n = 16$ is consistent with our results. The specimen they used was obtained from a botanical garden in Japan, but its source is unknown. They do state that the application of the name, *P. pilosa,* in Japan is in doubt and *P. pilosa* is not listed as a member of the flora of Japan by Ohwi (1984). The specimen used by Kim and Carr (1990) to obtain their count of $2n = 16$ was from a plant growing wild in Hawaii. *Portulaca pilosa* is a naturalized component of the Hawaiian flora (Wagner et al. 1990).

We have counted root tip chromosomes over a large geographical range with the following results (Table 2). Plants collected from Mexico, FL, GA, and AL had $2n = 16$ (Figs. 9, 10). However, in SC, TN, AR, OK, TX and NM the number is $2n = 8$ (Figs. 11, 12). This is consistent with Steiner's (1944) report from FL and of an unidentified species of *Portulaca* from Springdale, AR with $2n = 8$. In Steiner's opinion, this latter specimen constituted a new species, and would correspond to *P. mundula* Johnston (1948).

Exhibiting a different chromosome number is not sufficient reason to desig-

TABLE 2. Collectors and localities for chromosome voucher specimens of *P. pilosa.*

2n	Voucher
16	MEXICO. Quintana Roo: Yucatan, 25 Jul 1990, *Matthews s.n.* (UNCC).
16	FLORIDA. Lee Co.: Ft. Myers, 25 May 1990, *Matthews s.n.* (UNCC).
16	FLORIDA. Collier Co.: Big Cypress Nature Preserve, 3 Jan 1991, D & S. *Black s.n.* (UNCC).
16	ALABAMA. Lee Co.: Loachapoka, 26 Mar 1992, *Allison 1102* (UNCC).
16	GEORGIA. Crisp Co.: Little Rock Ch., 26 Mar 1992, *Allison s.n.* (UNCC).
8	SOUTH CAROLINA. Beaufort Co.: Lemon Island, 12 Oct 992, *Matthews s.n.* (UNCC).
8	TENNESSEE. Wilson Co.: Cedars of Lebanon St. Pk., 5 Jul 1981, *Allison 1821* (UNCC).
8	ARKANSAS. Benton Co.: Sprindale, 16 Aug 1973, *Smith 1763* (UNCC).
8	OKLAHOMA. Cimarron Co.: 21 Aug 1984, *J.& C. Taylor s.n.* UNCC).
8	TEXAS. Brewster Co.: Big Bend National Park, 29 Sep 1990, A.M.& S.A. *Powell 5650* (UNCC).
8	TEXAS. Colorado Co.: New Ulm, 9 Sep 1990, *K. Northrup s.n.* (UNCC).
8	TEXAS. Hidalgo Co.: Edinburg, 30 Sep 1990, *B. Lonard s.n.* (UNCC).
8	TEXAS. Jeff Davis Co.: Mitre Peak, 27 Sep 1990, *M. Lockwood & M. Forstner 25* (UNCC).
8	TEXAS. Kinney Co., Kickapoo Caverns St. Pk.: 4 Aug 1990, *T. Keeney 10076* (UNCC).
8	TEXAS. Uvalde Co.: Knippa, 23 Sep 1990, *T. Keeney 10070* (UNCC).
8	NEW MEXICO. Luna Co.: Florida Mts., R.D. Worthington s.n. (UNCC).

nate a new species. This is particularly true in the Portulacaceae. Lewis' extensive work with *Claytonia virginica* showing three ploidy levels, a diploid represented by $n = 8,7$ and 6 races, a triploid of $n = 12$ and 11, and a tetraploid of $n = 16,15$ and 14 (Lewis & Semple 1977) illustrate the multiplicity of chromosome numbers in another genus in this family. Our report (Matthews et al. 1992) on the occurrence of $2n = 18,36$ and 54 in *P. umbraticola* Kunth, and the various literature reports of polyploidy in *P. oleracea* L. with $2n = 18$, 36, and 54 (Danin et al. 1978, Khullar & Dutta 1973, Steiner 1944, and Hagerup 1932) substantiate the variable levels of ploidy in *Portulaca.*

We think it is important that the $2n = 8$ and 16 is different from most of the chromosome numbers in the genus. The usual base number is $n = 9$. This makes the red/purple-flowered *P. pilosa* cytologically different from most of the other species in the genus. Steiner's report for *P. smallii* P. Wilson as $2n = 16$ is in error and should be $2n = 18$, which will be detailed in a later paper, along with a new report for the yellow-flowered, *P. rubricaulis* Kunth, of $2n = 16$.

CYTOLOGICAL AND MORPHOLOGICAL RELATIONSHIPS

Since the two cytodemes are geographically distinct, we decided to determine if there was a correlation of chromosome number with pedicel length and capsule diameter. Table 3 shows a comparison of the 15 populations from which we counted chromosomes and from which we were able to measure the characters. For both pedicel length and capsule diameter, both the $2n = 8$ and $2n = 16$ populations are distributed across the entire range. All the populations overlap, although the least overlap is in the extremes, but there is no correlation with the

TABLE 3. Comparison of pedicel lengths and capsule diameters for known chromosome no. (#) populations from Alabama (AL), Florida (FL, Collier and Lee cos.), Georgia (GA), Mexico (MX), New Mexico (NM), Oklahoma (OK), Tennessee (TN), Texas (TX, Brewster, Colorado, Hidalgo, Jeff Davis, Kinney, Uvalde cos.). Means connected by lines are not significantly different at the 0.05 level. (However, because of small sample sizes, some anomalous gaps occur in the extremes of the comparison.)

PEDICELS

Pop:	TN	OK	MX	TX-JD	FL-C	TX-K	TX-B	TX-H	SC	FL-L	AL	TX-U	TX-C	GA	NM
#:	8	8	16	8	16	8	8	8	8	16	16	8	8	16	8
X	.211	.222	.230	.243	.275	.367	.388	.443	.557	.578	.578	.617	.625	.700	.725
SD	.078	.097	.067	.053	.095	.150	.112	.237	.257	.249	.148	.117	.292	.208	.225
N	9	9	10	7	4	6	8	7	7	9	6	8	7	8	

CAPSULES

Pop:	OK	NM	TN	TX-K	TX-JD	TX-H	FL-C	TX-C	FL-L	SC	GA	TX-B	TX-U	MX	AL
#:	8	8	8	8	8	8	16	8	16	8	8	16	16		
X	1.49	1.65	1.78	2.00	2.13	2.17	2.17	2.21	2.24	2.30	2.33	2.35	2.58	2.67	2.77
SD	.196	.214	.156	.385	.243	.335	.275	.300	.375	.374	.214	.302	.376	.424	.466
N	9	8	9	6	7	7	4	8	9	7	7	8	6	10	9

FIG. 5. Type of *Portulaca mundula* Johnston, densely pilose from the desert habitat in Coahuila, MX.

FIG. 6. Densely pilose specimen of *Portulaca pilosa* L. from Tampa, FL, collected in 1891.

FIG. 7. Sparsely pilose paratype of *Portulaca mundula* Johnston from Osage Co., OK., a cooler habitat.

FIG. 8. Sparsely pilose paratype of *Portulaca mundula* Johnston from the higher elevations in Coahuila, MX.

chromosome number. Several gaps occur in the comparison of the capsule diameter due to the small sample sizes. To test the multivariate effect of pedicel length and capsule diameter, a discriminant analysis was performed on the 15 populations, as described above. Misclassification percentages are as follows: AL(16)-56%, FLC(16)-75%, FLL(16)-100%, GA(16)-71%, MEX(16)-30%, NM(8)-38%, OK(8)-22%, SC(8)-100%, TN(8)-44%, TXB(8)-88%, TXC(8)-100%, TXH(8)-100%, TXJ(8)-71%, TXK(8)-83%, TXU(8)-83%. In general, the discriminant function performed poorly in separating the populations of the two cytodemes, based on these two characters.

CONCLUSION

Portulaca pilosa L. exists as a tetraploid in Mexico and in the lower southeastern United States. In the upper southeast and westward into the southwest it is a diploid. Morphological features are not consistent with ploidy levels and no consistent morphological characters are apparent. There is one morphological

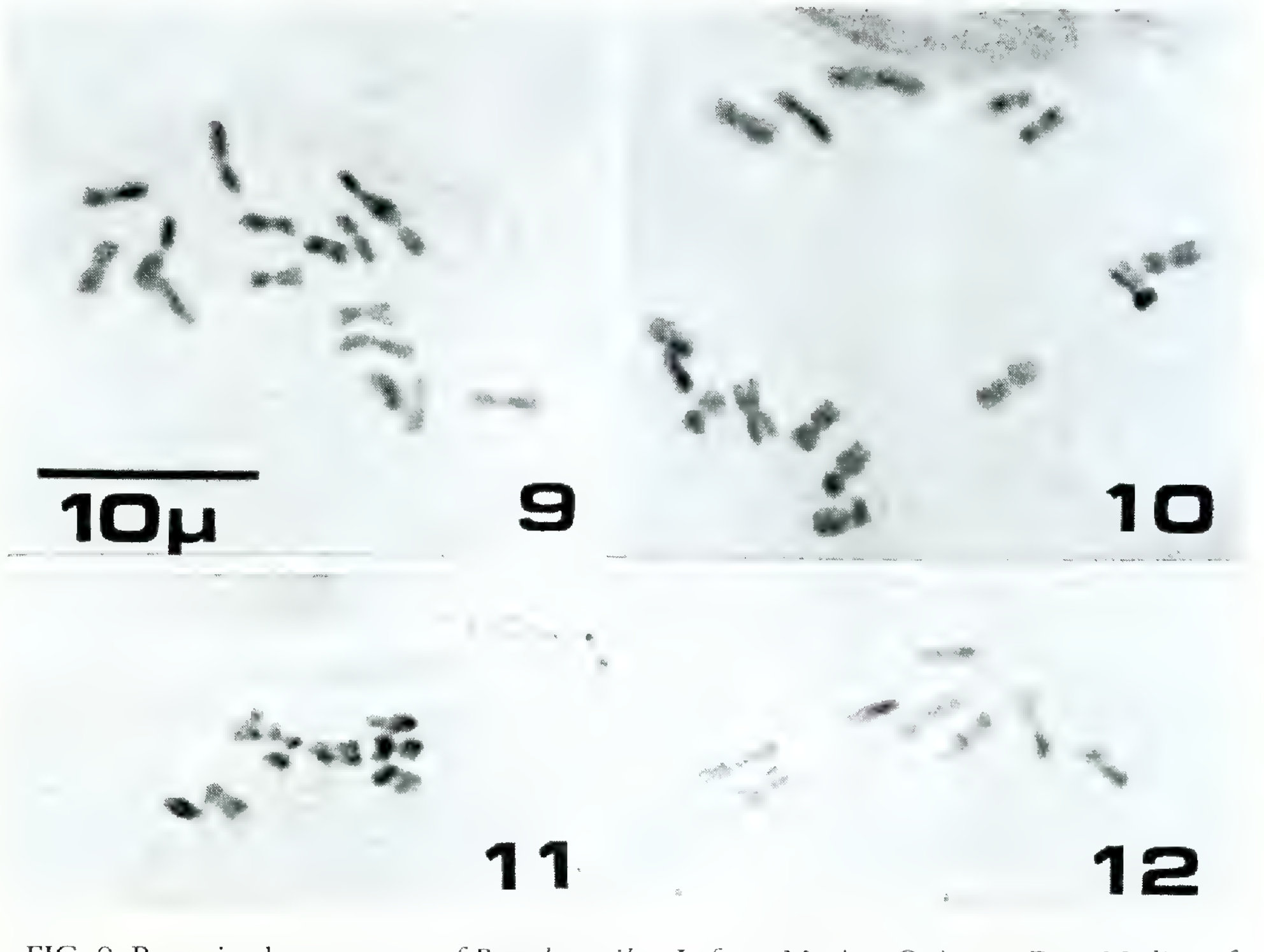

FIG. 9. Root tip chromosomes of *Portulaca pilosa* L. from Mexico. Quintana Roo: Median of main highway at Capt. Cove Restaurant, Cancun, 25 Jul 1990, *Mattheus s.n.* (UNCC).

FIG. 10. Root tip chromosomes of *Portulaca pilosa* L. from Florida. Lee Co.: Sandy roadside, McGregor Blvd. at San Carlos Blvd., Ft. Myers, 25 May 1990, *Mattheus s.n.* (UNCC).

FIG. 11. Root tip chromosomes of *Portulaca pilosa* L. from South Carolina. Beaufort Co.: Roadside, SC 170, W side of Lemon Island, W of Chechasee River, 12 Oct 1990, *Mattheus s.n.* (UNCC).

FIG. 12. Root tip chromosomes of *Portulaca pilosa* L. from Texas. Brewster Co., Near LH Creek, Meriwether ranch, ca. 16 mi S of Alpine, 13 Sep 1990, *D. Broun s.n.* (UNCC).

taxonomic entity existing from the Caribbean up through Florida, into the southeastern United States, across into the midwest and southwestern United States into the Mexican desert, having two cytotypes that are related ($2n = 8$ and 16) in comparison with the remainder of the genus (mostly $2n = 18$). These cytotypes can be distinguished morphologically only when extremes of morphological expression, apparently dictated by geography, climate and habitat, are compared. Hence, *P. pilosa* L. in the United States is a widely variable species, having $2n = 8$ and 16. It has red/purple flowers, pilose leaf axils and inflorescences that vary from moderately to densely woolly. The seed surfaces are S-undulate (stellate) with or without tubercules.

A question may arise as to why infraspecific categories are not recommended, such as was done by Legrand (1962), where he recognized *P. pilosa* var. *mundula* (I.M. Johnst.) Legrand. At this point in the evolution of this species, even though

two cytotypes exist, there are no geographical separations nor any morphological traits that can be used to distinguish two entities in the United States. When such distinctions do exist, and contribute to a functional taxonomy for the group, we recognize them, as we did for *P. umbraticola* Kunth (Matthews & Ketron 1991).

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Turner, Nancy J., Adma F. Szczawinski. 1991. **Common Poisonous Plants and Mushrooms of North America.** Timber Press, Inc., 9999 SW Wilshire, Portland, Oregon 97225. Hardbound. $58.75. 311 pp.

An illustrated text on Poisonous Garden, House and Crop Plants and Poisonous Mushrooms. Chapter 1: Describes recognizing poisonous plants and their effects, treatment and types of plant poisons. Chapter 2: Poisonous mushrooms. Chapter 3: Poisonous Plants of Wild Areas. Chapter 4: Poisonous Garden Crop Plants (including Weeds), Trees, Shrubs, Hedge Plants, Vines, and Flowers. Chapter 5: Poisonous House Plants and Plant Products. Appendix 1: Common Fruits, Vegetables, and Beverage Plants containing potentially harmful toxins. Appendix 2: Wild Edible Plants with potentially toxic properties. Appendix 3; Some common plants causing skin irritation and/or mechanical injury. Appendix 4: Honey poisons. Appendix 5: Milk poisons. Appendix 6: some medicinal Herbs of questionable safety. There is a glossary, references and many photographs. This book is a good reference for any one interested in knowing the common poisonous plants and mushrooms. *Krishna Puttaparthi.*

Crellin, John K. and Jane Philpott. 1990. **Herbal Medicine Past and Present. Volume II A Reference Guide to Medical Plants.** Duke University Press, 6697 College Station, Durham, North Carolina, 27708. Paper $19.95. 549 pp.

This guide records the knowledge of Appalachian herbalist A.L. Tommie Bass. The text list the plants alphabetically according to well-known vernacular names. The plant is described first by Mr. Bass then the authors' commentaries. The commentaries include references to history of the plant, uses, plant description, distribution, collection, storage, scientific names and synonyms. There are descriptions of 700 medicinal plants. Anyone interested in medicinal plants, ethnobotany and ethnopharmacology will appreciate this book. *Dotty Woodson.*

Wesson, Robert. 1991. **Beyond Natural Selection.** The MIT Press, 55 Hayward St., Cambridge, Mass. 02141. Hardbound $29.95. 353 pp.

An interesting text on evolution. Chapter 1 and 2 addresses the conventional Darwinian theory. The next six chapters examine why natural selection can be considered insufficient and how inherent potentials need to be thoroughly examined. Chapter 3 discusses the incomplete fossil record of life. Chapter 4 examines living creatures that do not fit the accepted theory. Chapter 5 discusses adaptation that are useful and those with no apparent utility. Chapter 6 examines sexual habits and the need to mix genes. Chapter 7 discusses social behaviors. Chapter 8 considers the dynamics of evolution. Chapter 9 examines how genetic patterns influence evolution. Chapter 10 discusses change of pattern. Chapter 11 examines the relationship of heredity and environment and genetic response. Chapter 12 discusses the evolution of humans. Chapter 13 states the argument for the autonomy of the genome. *Dotty Woodson.*

Sida 15(1): 90. 1992

A NEW *BUPLEURUM* (UMBELLIFERAE) FROM CENTRAL CHINA

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ABSTRACT

A new species, *Bupleurum sichuenense*, from Wenchuan District of northwestern Sichuan Province of China, is diagnosed, described and figured, and compared with the two most similar species, *B. malconense* Shan et Y. Li and *B. chaishoui* Shan et Sheh. Besides, a key is given for distinguishing the five most closely related species of the genus.

Bupleurum sichuanense S.L.Pan et Hsu, sp. nov. (Fig. 1)

Species *B. malconensi* Shan et Y. Li affinis, sed differt foliis angustioribus brevioribus tenuioribusque, 7-nervis, radiis plurioribus, phyllis involucelli minoribus 1 – 2 mm longis, pedicellis distincte brevioribus. Similis etiam *B. chaishoui* Shan et Sheh, quod dimorphophyllis, radiis 3 – 5, involucelli phyllis pedicellis longioribus facile distinguitur.

Perenne; tota planta glaberrima. Radix elongata, 2 – 7 mm crassa, brunnea vel cineracea, raro ramifer, pluriceps. Caules plerumque nemerosi, caespitosi, usque 40 – 100 cm alti, recti, graciles, firmi, ca. 1 – 2 mm diametro, basi residuis vaginarum emortuorum instructo. Folia in sicco chartacea, radicalia-basin tenuioria, linearia, 2 – 10 cm longa et 1 – 5 mm lata, apice apiculata vel breviacuminata, ad basin versus sensim in petiolum angustata, 7-nervia, extinis in margine ipso currentibus, nervis subtus valde prominentibus, nervulis venisque omnino inconspicuis; caulina media et superiora inferioribus conformia, sed leviter parvioria, 5 – 7 nervia. Umbellae 1 – 2 cm diametro, longe pedunculatae, pedunculis 1.5 – 4.5 cm longis; involucri phylla 1 – 3, minuta, linearia vel squamiformia, inaequalia, 0.5 – 3 mm longa et 0.1 – 0.5 mm lata, 1 – 5 nervia; radii (4-)6 – 7 (-8), 1 – 2 cm longi; umbellulae 2 – 3 mm diametro; phyllla involucelli 5, lanceolata, 1 – 2 mm longa et 0.2 – 0.8 mm lata, umbellulis floriferis

SIDA 15(1): 91 – 93. 1992

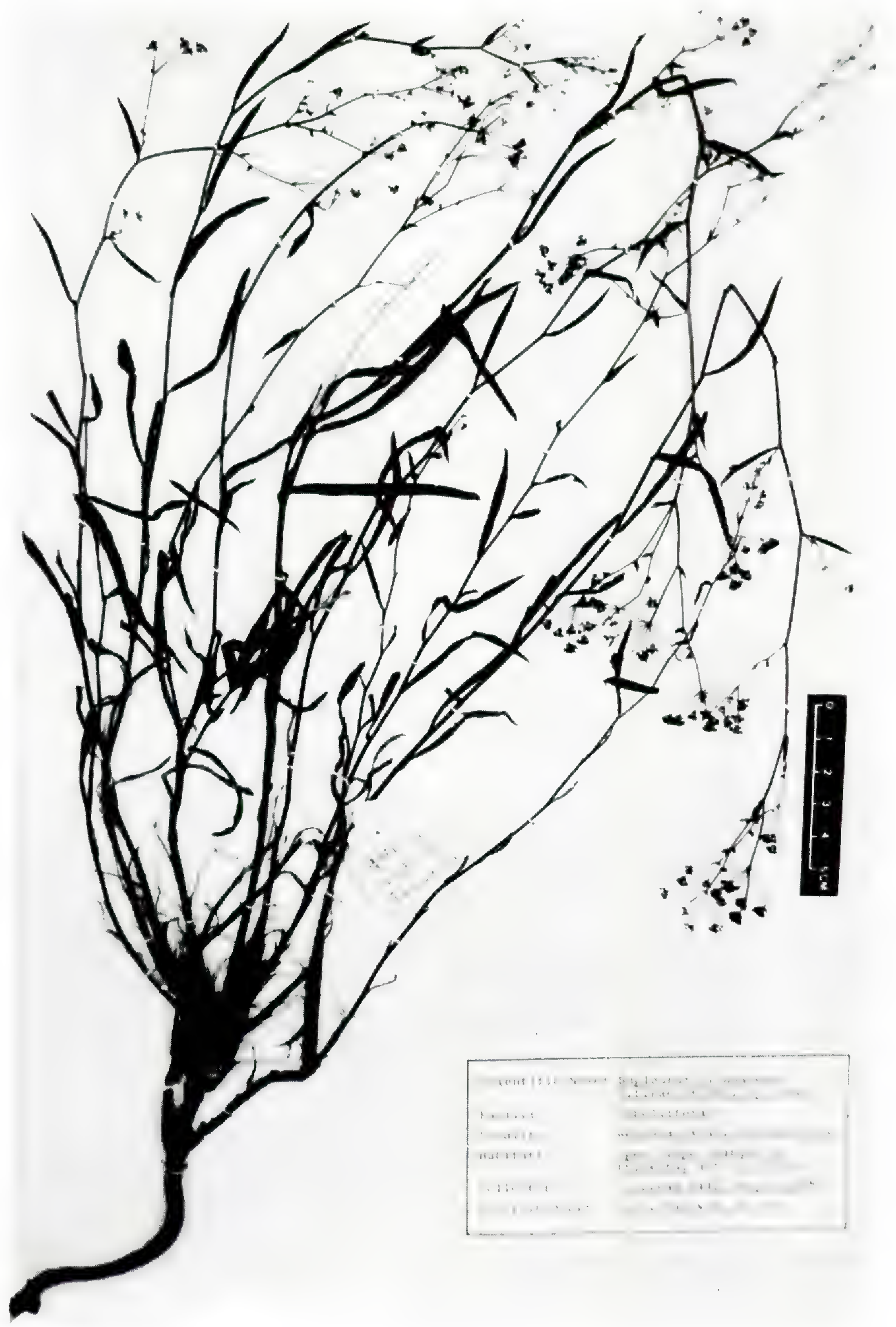

FIG. 1. Holotype of *Bupleurum sichuanense.*

parum breviora vel subaequilonga; flores in umbellula 5 – 11, breviter (0.5 – 1 mm) pedicellati; petala flava, ca. 1 mm diametro; ligula subrectangulo, apice emarginato, petalorum tertiam partem subaequantia. Fructus subellipsoidei, 2 – 3 mm longi et 1.2 – 1.5 mm lati, pedicello 1.5 – 2.5 mm longo, valleculis 4-sulcatis, 3-vittatis.

TYPE: CHINA. SICHUAN PROVINCE: Wenchuan District, alt. ca. 2000 m, on open slope, margin of thickets, 21 Aug 1985, *S.L. Pan 0442,* (PE); same locality, 7 Sep 1985, *S.L. Pan 0436* (SHMI).

A key to the five most closely related species of *Bupleurum* is given as follows:

1. Stem single, not caespitose.
   2. Rays of umbel 1 – 3; leaves small, few; stem much-branched ..... *B. wenchuanense* Shan et Y. Li
   2. Rays of umbel more than 4; leaves very long and narrow, more numerous; stem sparsely branched ..... *B. microcephalum* Diels
1. Stem numerous, caespitose.
   3. Leaves dimorphic, the basal ones and those on the lower part of the stem obovate-lanceolate, differs remarkably from those in the middle and upper part of the stem which are oblong or short linear and much smaller ..... *B.chaishoui* Shan et Sheh
   3. Leaves uniform, linear.
      4. Involucel bracts more than 2 mm long, exceeding the pedicel; leaves firm, up to 15 cm long; rays of umbel usually less than 5 ..... *B. malconense* Shan et Y Li
      4. Involucel bracts less than 2 mm long, shorter than the pedicel; leaves tender, at most 8 cm long; rays of umbel usually 6 – 7 ..... *B. sichuanense* S.L. Pan et Hsu

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BECHTEL, HELMUT, PHILLIP CRIBB and EDMUND LAUNERT. 1992. **The Manual of Cultivated Orchid Species.** Third Edition. The MIT Press, 55 Hayward St., Cambridge, Mass., 02142. Hardbound $85.00. 585 pp.

This reference manual can be used by orchid collectors and growers for identification, cultivation and nomenclature. The first section includes short informative chapters on morphology, life cycles, ecology, history, cultivation, hybridization, conservation, nomenclature and classification.

Part two, the majority of the book, covers the cultivation of species in cultivation. The text is in alphabetical order by genus then species. Under the generic heading is a description of the distinguishing features, distribution, derivation of name, taxonomy, type species, synonym, and culture. Under the species heading is again a description, distribution, history, and synonyms.

There are 357 genera and 1,500 species described. The book has 864 color photographs, 62 line drawings, a glossary, an index of synonyms and an index of related species. *Dotty Woodson.*

VANDERPLANK, JOHN. 1991. **Passion Flowers and Passion Fruit.** MIT Press, 55 Hayward St., Cambridge, Mass., 02142. Hardbound $35.00. 176 pp.

This monograph can be used by botanist and grower for identification and cultural information. The text includes chapters on classification and structure, the legend of the passion flower, cultivation, propagation, hybridization, butterflies and pest and diseases. Chapter 5 list the species, hybrids and varieties in alphabetical order by species. Each species is described with taxonomial description, distribution, synonyms and culture. There is an identification key and glossary. There are 160 illustrations and 60 color plates. *Dotty Woodson.*

PARKINSON, JOHN. 1991. **A Garden of Pleasant Flowers. Paradisi in Sole Paradisus Terrestris.** Facsimile of 1629 edition. Dover Publications, 11 East 2nd Street, Mineola, N.Y. 11501. Paper $24.95. 640 pp.

This is a republication of John Parkinson's horticultural guide of 1000 plants from all over the world that could be grown in England. John Parkinson was the apothecary to King James I and botanist to Charles I. 812 plants are illustrated on 108 full-page plates. The text is divided into three sections, The Garden of Pleasant Flowers, The Kitchen Garden and The Ordering of the Orchard. *Dotty Woodson.*

WEST, KEITH. 1992. **Painting Plant Portraits: A Step by Step Guide.** Timber Press, 9999 S. W. Wilshire, Portland, Oregon 97225. Hardbound $32.95. 112 pp.

The author beautifully demonstrates the stages of painting twelve plants. The author illustrates each step from pencil drawing to the finish water coloring. A commentary explains each step and technique. Anyone interested in learning to paint plant with water color will be delighted to read this book. There are 120 color illustrations. *Dotty Woodson.*

A NEW COMBINATION IN *MINUARTIA* (CARYOPHYLLACEAE)

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After examining type specimens of several taxa in association with my treatment of the Caryophyllaceae for the Generic Flora of the Southeastern United States, I find the following combination is necessary:

Minuartia muscorum (Fassett) Rabeler, comb. nov.—*Stellaria muscorum* Fassett, Rhodora 39:460. 1937. *Arenaria fassettii* Shinners, Sida 1:51. 1962.—TYPE: OKLAHOMA. Delaware Co.: wet, springy limestone cliff, Dripping Springs, 19 Apr 1936, *Fassett & Watts 18030* (HOLOTYPE: WIS; ISOTYPE: MO!, GH!).

Arenaria patula Michaux forma *robusta* Steyermark, Rhodora 43:330. 1941.—*A. patula* var. *robusta* (Steyermark) Maguire, Amer. Midl. Naturalist 46:507. 1951. *Minuartia patula* var. *robusta* (Steyermark) McNeill, Rhodora 82:499. 1980.—TYPE: MISSOURI. Butler Co.: Gillis Bluff, 5 mi W of Quilin, 27 May 1939, *Steyermark 26652* (HOLOTYPE: F!; ISOTYPES: GH, MO!).

Arenaria muriculata Maguire, Amer. Midl. Naturalist 46:507. 1951.—*Minuartia muriculata* (Maguire) McNeill, Rhodora 82:499. 1980.—TYPE: ARKANSAS. Prairie Co.: prairies, 215 ft elev., Ulm, 9 May 1937, *Demaree 14920* (HOLOTYPE: NY!; ISOTYPE: MO!).

Except for Shinners' (1962) transfer of *Stellaria muscorum* to *Arenaria,* this taxon has been ignored since Fassett (1937) described it. The type gathering of *M. muscorum* has slightly larger leaves and longer internodes and pedicels than the type specimens of *A. patula* var. *robusta,* but shares the annual habit, cymose inflorescence, 3-nerved sepals, and large petals. Although Fassett's collection was gathered too early to include seed, a later collection from the same site (10 May 1959, *Wallis 8188,* VDB) has the black, shiny, muriculate seeds that both characterize *M. muriculata* and segregate that taxon from *M. patula* (see Wofford 1981).

Curiously, Maguire (1951) and McNeill (1980) recognized both *M. muriculata* and *M. patula* var. *robusta.* A comparison of the descriptions of the taxa (Maguire 1951, Steyermark 1941) respectively reveals that both taxa have 3-nerved (vs. 5-nerved in var. *patula*) sepals, wider leaves than *M. patula* var. *patula,* and seeds exceeding 0.7 mm wide (vs. 0.5-0.7 mm wide in var. *patula*). Under his entry for *Arenaria muriculata,* Smith (1988) stated "Material that I earlier treated as *Arenaria patula* Michx. var. *robusta* (Steyerm.) Maguire is actually this species;" specimens at UARK were annotated likewise by John McNeill. While Maguire described the seed surface of *M. muriculata,* neither he nor Steyermark did so for

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M. patula var. *robusta.* Had that been done, the parallel treatments may have been recognized sooner.

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DISTRIBUTION AND STATUS OF *ASTRAGALUS TENNESSEENSIS* (FABACEAE) IN ALABAMA

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ABSTRACT

Astragalus tennesseensis Gray ex Chapman (Fabaceae) is a cedar glade endemic that was first collected in Alabama by Professor Thomas P. Hatch in the 1850s. Evidence is presented that suggests his specimen was collected in Colbert County rather than in Lauderdale County, Alabama. The historic distribution of *A. tennesseensis* in Alabama was confined primarily to the Moulton Valley of the Interior Low Plateau. Recent field surveys have documented seven extant populations of this species in Alabama. Without protection, these populations likely will decline, and the species possibly could be extirpated from the southern portion of its historic range.

INTRODUCTION

The perennial legume *Astragalus tennesseensis* Gray ex Chapman (Tennessee milk vetch) is a cedar glade endemic (Baskin and Baskin 1986) whose historic range extended from northern Illinois and east central Indiana south to middle Tennessee and northern Alabama (Barneby 1964, Baskin et al. 1972, Isely 1986). With the exception of a single extant population that occurs on a gravel hill prairie in Tazewell County, Illinois (McFall 1984), *A. tennesseensis* apparently has been extirpated from the northern portion of its range (Baskin and Baskin 1986). It recently has been reintroduced at Wea Gravel Prairie, Tippecanoe County, Indiana (Bowles 1988, LeBlanc 1988), at the only site in that state where it has ever been collected (Hauser et al. 1981). Although most abundant in cedar glade communities in middle Tennessee (Baskin et al. 1972, Kral 1983, Somers and Shea 1990), *A. tennesseensis* is reported from a few localities in glade habitats in northern Alabama (Mohr 1901, Barneby 1964, Baskin et al. 1968, 1972, Kral 1983, Baskin and Baskin 1986, Isely 1986). The species is listed as threatened in Alabama (Freeman et al. 1979a, 1979b), endangered in Tennessee (Somers 1989) and Illinois (Sheviak 1981), and extirpated in Indiana (Bacone and Hedge 1980). It is currently under review by the U.S. Fish and Wildlife Service for possible listing as an endangered or threatened species [FR 55 (35):6184-6229, 21 Feb 1990].

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The purpose of this paper is to document the known distribution and status of *A. tennesseensis* in Alabama based on field surveys, conducted by the authors in 1989, 1990, and 1991, on the floristics of cedar glades in Colbert, Franklin, Lawrence, Morgan, Marshall, and Jackson counties. In addition, old reports of *A. tennesseensis* in Alabama have been reviewed in an attempt to accurately determine the historical distribution of the species in the state and to clarify collection localities mentioned in these reports.

THE HATCH COLLECTION

The first known collection of *A. tennesseensis* from Alabama was made by Professor Thomas P. Hatch in the 1850s. Hatch was a member of the faculty at LaGrange College (McGregor, no date, Sheridan 1980), which was the first chartered college in Alabama. The site of the original LaGrange College was the small village of LaGrange located about five km southwest of the town of Leighton in what is now Colbert County, Alabama (Fig. 1). The site of LaGrange was unknown to Barneby (1964) who commented that the location where Professor Hatch collected *A. tennesseensis* "...has not been identified...."

Mohr (1901) and Barneby (1964) list Lauderdale County as the locality for the Hatch collection. The basis for assuming that Hatch's *Astragalus* collection was from Lauderdale County likely resulted from an article published by Hatch (1856) entitled "Floral Calendar, for part of 1855, in Lauderdale County, Alabama"; by Thos. P. Hatch, Professor of Natural Science in La Grange College, Florence, Alabama. In this article, Hatch includes an *Astragalus* that he considered to be an undescribed species.

While the original LaGrange College was located in what is now Colbert County, the entire faculty, with the exception of a single member, moved to Florence, Alabama, in January 1855. The college in Florence was for a brief time called LaGrange College, but it failed to receive a charter under the original name and became known as Florence Wesleyan University (now the University of North Alabama). The LaGrange College near Leighton acquired a new faculty and reopened. The buildings of LaGrange College were burned in 1863 by the Union army, and the college was never rebuilt (McGregor undated, Sheridan 1980).

A specimen of *Astragalus* collected by Hatch was sent to Professor Asa Gray at Harvard University. The specimen was used by Gray in describing *A. tennesseensis* and is cited by Barneby (1964) as a paratype. The Hatch specimen is contained in the collections of the Gray Herbarium (GH!) and is mounted on the same sheet as the holotype for *A. tennesseensis* that was collected by Lesquereux near Nashville, Tennessee. A neatly clipped fragment of a letter from Professor Hatch to Asa Gray is contained within a packet on the herbarium sheet. The original letter apparently contained notes on several different species, and the section

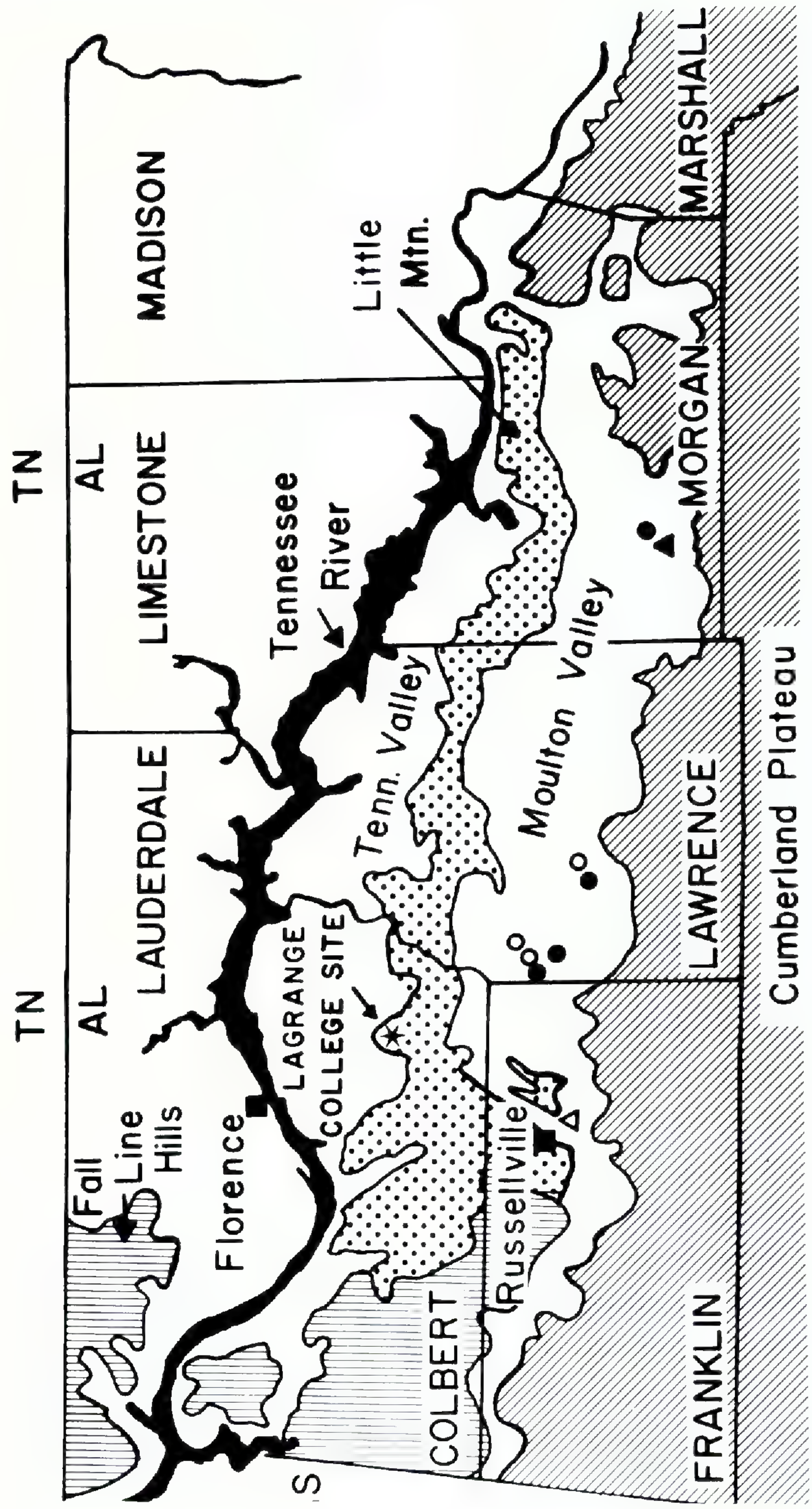

Fig. 1. Distribution of *Astralagus tennesseensis* in northern Alabama: populations of 50 – 150 plants (○); populations of less than 50 plants (●); approximate locality for Mohr collection (∧); and recently extirpated population (▲). Generalized physiographic map is modified from Harper (1942) and Sapp and Emplaincourt (1975).

pertaining to *Astragalus* was cut out and placed with specimen. One side of the fragment includes the heading and salutation that identifies the letter as being sent to Gray from LaGrange, Alabama, on May 5, 1854. The reverse side contains the following information relating to the *Astragalus* specimen:

> I have met with in but two localities during five years of botanical observation a single bed of it in Sumner County, Tennessee, & a single plant in this vicinity. It appears to be an *Astragalus* but the stipules being adnate to the petiole, its smooth pericarp and the cales of its flowers separate it from everything under that genus. It is always prostrate or at most assurgens & never much exceeds this in height.

From the letter fragment, it appears that the specimen was collected and mailed prior to the move of LaGrange College to Florence in 1855. Apparently, *A. tennesseensis* also was rare in the vicinity of LaGrange since Hatch had seen only a single plant. The 1854 date on the herbarium sheet, referring to the Hatch specimen, apparently was altered to 1855, causing further confusion.

While the exact locality where the Hatch specimen was collected likely will never be determined, it seems logical that it was from the vicinity of the LaGrange College site in Colbert County, Alabama. Extensive glades occur about 15 km south of the LaGrange site in Franklin and Lawrence counties, and a small glade complex with several cedar glade endemics, including *Lesquerella lyrata* Rollins (Webb and Kral 1984), occurs within 5 km of the old LaGrange College site in Colbert County. The cedar glade community of which *A. tennesseensis* is typically a component is not known to occur in Lauderdale County. Hatch (1856) also included *Leavenworthia aurea* Torrey in his floral calendar of Lauderdale County. This collection probably was *L. alabamica* Rollins, which is abundant in glades south of the Tennessee River but is not reported by Rollins (1963) from Lauderdale County on the north side of the Tennessee River. Harper (1928) also notes that Hatch's floral calendar related "...to the vicinity of LaGrange College, which was on Little Mountain, in what is now Colbert County." Thus, it is probable that the plant list and floral calendar of Hatch included a wider geographic area than the title would imply.

DISTRIBUTION

Field surveys by the authors have documented seven extant populations and one recently extirpated population of *A. tennesseensis* in Lawrence and Morgan counties (Fig. 1). The populations are within a subdivision of the Interior Low Plateau Physiographic Province (Fenneman 1938) referred to by Harper (1942) and earlier authors as the Moulton Valley. The Moulton Valley contains outcroppings of Bangor limestone of Mississippian age, and in Alabama extends from the Alabama/Mississippi state line (Franklin County) eastward through Lawrence and Morgan counties into extreme western Marshall County (Harper 1942).

A specimen of *A. tennesseensis* from the Mohr Herbarium (UNA!) that presumably was collected in the late 1800s. extends the historical distribution to the western portion of the Moulton Valley near Russellville. The herbarium label on the specimen describes the collection locality as "Shaded limestone rocks in Russel valley. Locust Dell near Russellville." The "Locust Dell" cited by Mohr has not been relocated, and no extant populations of *A. tennesseensis* have been found in the vicinity of Russellville. However, glade habitat occurs in the area, and other cedar glade endemics including *Delphinium alabamicum* Kral, *Pediomelum subacaule* (Torrey & Gray) Rydberg, *Onosmodium molle* Mich. subsp. *molle, Oxalis priceae* Small subsp. *priceae, Dalea gattingeri* (Heller) Barneby, and *Leavenworthia alabamica* Rollins var. *alabamica* are known from sites near Russellville.

Historical and recent collections indicate the historical distribution of *A. tennesseensis* in Alabama largely was confined to the Moulton Valley in Franklin, Lawrence, and Morgan counties. A possible exception is the Hatch specimen that apparently was collected in the vicinity of the old LaGrange College site in Colbert County, not in Lauderdale County as cited by Mohr (1901) and Barneby (1964). The nearest known glades to LaGrange College are in the Tennessee Valley portion of the Interior Low Plateau.

POPULATION STATUS

Four of the seven known extant populations of *A. tennesseensis* in northern Alabama consist of less than fifty plants each (Fig. 1). Three of these occur primarily along road right-of-ways, and thus could be extirpated or significantly reduced if the roads are widened. One of the roadside populations was sprayed with herbicide in 1991. The fourth population, consisting of two plants, inhabits a small glade opening in cedar woods and could disappear in the near future due to natural succession. The other three populations are much larger, and each consists of an estimated 50 to 150 individuals. At the present time, land use at these three sites does not pose an immediate threat to *Astragalus* populations. One small population of *A. tennesseensis* in Morgan County (Fig. 1) with three plants in 1989 was not observed during a field survey in 1991 and appears to have been extirpated.

All of the known populations of *A. tennesseensis* in Alabama are on privately owned lands or road right-of-ways. Dumping of trash, road improvement and road maintenance, construction of fences, grazing, development, and conversion of land to forage crops are threats to existing populations. Further, individuals of *A. tennesseensis* are short-lived, and thus plants must often become established from seeds if populations are to persist (Baskin and Baskin 1989). Unless protective measures are instituted, populations of the Tennessee milk vetch likely will decline in Alabama and possibly be extirpated from the southern portion of its historic range.

VOUCHER SPECIMENS

Voucher specimens for seven of the populations cited in this paper have been deposited at VDB as follows: **Lawrence Co.:** *Webb 5518, 5554, 5570, 5752, 5764.* **Morgan Co.:** *Webb, Baskin & Baskin 5487, 5488, 5490.*

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BOOK REVIEWS

AJILVSGI, GEYATA. 1990. **Butterfly Gardening for the South**. Taylor Publishing Company, 1550 W. Mockingbird Ln, Dallas, Texas 75235.

This is a wonderful book with 200 beautiful full-color photographs of butterflies and plants. Chapter 1 covers the life cycles of butterflies. Chapter 2, 3 and 4 describe how to landscape your garden with nectar plants and larval food plants. There are twelve landscape designs and suggestions for different areas of Texas. Chapter 5 discusses butterfly-friendly pest control. Chapter 7 describes butterflies of the south. The ones described were chosen to show the unusual variability to this area. They are loosely listed by size starting with the largest. Descriptions include common and scientific names, range, flight time, broods, over winters, egg, larva, and food plants. Chapter 8 list larval food plants by growth habit, trees, shrubs, vines and herbs. The descriptions include common and scientific names, bloom period, range, height, class (native, escaped or naturalized) cultivation, parts eaten and by which larvae. Chapter 9 used the same formation for nectar plants. The appendices include a brief text on how to photograph butterflies, hardiness zone map, Texas region map, list of South Florida butterflies, seed and plant sources and other helpful information. *Dotty Woodson.*

FALK, DONALD A. and KENT E. HOLSINGER, EDS. 1991. **Genetics and Conservation of Rare Plants**. Oxford University Press 200 Madison Ave., New York, N.Y., 10016. Hardbound $49.95. 283 pp.

Botanist, conservationist and geneticists will appreciate the information in this text. Part I examines the population biology and genetics of rare plants. Chapters discuss implications of small populations, genetic variation, minimum viable population theory and conservation of rare trees in the tropical rain forest. Part II examines the conservation of genetic diversity. The chapters discuss correlation between species traits and allozyme diversity, patterns of genetic variation and sampling strategies for genetic variation. Part III examines management and assessment of conservation collections. The chapters include methods for assessing genetic variation and long-term management of germ plasm. Part IV examines the application of theory and research for conserving diversity. Chapters cover strategies for conserving clinal, ecotypic and disjunct population diversity, hybridization of rare plants, off-site breeding, principles and prospects, and joining biological and economic models. The appendix in a guide for genetic sampling of conservation collections used by the center for plant conservation. This model will be useful to everyone researching endangered species. *Dotty Woodson*.

DISCOVERY OF *ORYZA RUFIPOGON* (POACEAE: ORYZEAE), NEW TO THE UNITED STATES, WITH ITS IMPLICATIONS[1]

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ABSTRACT

A population of Wild Red Rice (*Oryza rufipogon* Griff.) was discovered in the Everglades National Park in south Florida. It has been growing in the area since at least 1959. This is the first occurrence of this species in the United States. Previous reports of its occurrence in the United States were evaluated as incorrect.

RESUMEN

Una poblacion de arroz rojo silvestre (*Oryza rufipogon* Griff.) fue descubierto en el Parque Nacional Everglades en el sur de Florida. Ha estado creciendo en el area desde por los menos 1959. Es la primera ocurrencia de esta especie en los Estados Unidos. Registros previos de su occurrencia en los Estados Unidos fueron evaluados como incorrectos.

A number of exotic plants have been introduced and naturalized in Florida, with many becoming major weed problems (Gifford 1937, MacKenzie and Hall 1967, Vandiver 1980). From a botanical perspective one needs to be aware of plants extending their range because of possible negative economic impacts. In addition it is important to use correct taxonomic nomenclature when monitoring new plant introductions which have the potential to become weedy. Unless

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proper identification of a particular plant of interest is obtained, no accurate assessment of an increase in a plant's range is possible.

The genus *Oryza* has 22 species, including 20 wild and two cultivated species (Chang 1988, Tateoka 1963). The genus occurs in Australia, Burma, Central America, Sri Lanka, China, India, Indonesia, Malaysia, the Philippines, South America, and Thailand (Oka 1988b).

Oryza sativa L., cultivated rice of Asian origin (Oka 1988b), ranks with wheat in importance as a world food source (Chang 1985). The cultivated rice of African origin, *O. glaberrima* Steud., occurs primarily in West Africa, in the savanna on the southern region of the Sahara desert (Oka 1988b). Rice cultivation began in many parts of south and southeast Asia, perhaps first in India (Chang 1976), and weeds undoubtedly developed along with rice. Because of the importance of this crop, weeds which affect the quality and quantity of yields are critical in world food production.

Some major rice weeds are from the rice complex. Red Rice, *O. sativa* L. var. *fatua* Prain, is a widespread weed in cultivated rice, including production areas in the United States.

Wild Red Rice, *O. rufipogon*, is often found in non-taxonomic literature in the United States. *Oryza rufipogon* has apparently been erroneously applied to Red Rice in that literature, and thus has created confusion (Webster 1990).

The perennial *O. rufipogon* has not been reported previously in the United States. It occurs in Australia, Burma, Central America, China, India, Indonesia, Malaya, Philippines, South America, and Thailand. The grains are used as a famine food in some regions of the world, though of lower quality than cultivated rice.

A population of *O. rufipogon*, Wild Red Rice, documented first in July 1959, has been identified in Florida. It is growing in Taylor Slough near the Royal Palm Visitor Center, Everglades National Park, Homestead, Dade County, Florida, covering approximately 0.6 ha.

The *O. rufipogon* found in Florida is a perennial with a stout rhizome and fibrous roots. *Oryza sativa* var. *fatua* is an annual with a fibrous root system. The rhizome is a reliable means of identification for *O. rufipogon*.

The newly discovered *O. rufipogon*, a rhizomatous perennial, has erect to trailing culms which can reach 4.0 m in length. Leaf sheaths are smooth to somewhat scabrous distally. The membranous ligule is often lobed and up to 4.3 cm long. Auricles, 1.0 mm wide at the base, 0.3 mm wide at the tip, and 8.0 mm in length, are usually present (Duistermaat 1987). Leaf blades are up to 2.5 cm wide and 78 cm long. Inflorescences are up to 33 cm long. Spikelets are 8.0 to 9.6 mm long and have awns 3.0 to 5.0 cm long. The individual seeds on an inflorescence ripen at different times and fall over a period of several weeks. In South Florida flowering can begin in late October and continue into February.

Oka (1988a) described *O. rufipogon*, from which *O. sativa* is thought to have

originated, as exhibiting a perennial-annual continuum. However, Barbier (1989b) reported that in Thailand *O. rufipogon* is separated into two populations: (a) an annual population reproducing exclusively by seeds, and (b) a perennial population reproducing almost completely by asexual means. Barbier (1989a) also reported that the perennial population grows in low-lying areas that remain moist in the dry season, producing a small number of seeds and reproducing mainly by rhizomes. In contrast, the annual form grows in habitats that are parched during the dry season. The annual forms produce many seeds during a brief period, after which the plants become senescent.

A competitive weed in rice fields, *O. rufipogon* has the undesirable characteristic of hybridizing with *O. sativa*, cultivated rice (Reed 1977, Wirjahardja and Susilo 1979). With its competitive growth and inferior grain quality, *O. rufipogon* can lower the quality and the yield of domestic rice.

Plants with the potential to be particularly weedy in the United States have been designated as Federal Noxious Weeds by the United States Department of Agriculture, Animal and Plant Health Inspection Service (USDA, APHIS). This is in an effort to limit both the movement into and the spread within the country of these designated species.

In September 1987 Randy G. Westbrooks wrote to the Flora of North America (FNA) Newsletter requesting assistance in soliciting the help of botanists to determine past or present localities of Federal Noxious Weeds. In January 1988 the FNA Newsletter published this letter and a complete list of Federal Noxious Weeds. Collections in the University of Florida Vascular Plant Herbarium contain 16 Federal Noxious Weeds from Florida.

One species of concern was *O. rufipogon*, collected on 27 November 1985, the only record of *O. rufipogon* in the continental United States. The collection site is 100 km from the commercial rice producing region of Florida in the Everglades Agricultural Area. *O. rufipogon* represents a threat to the Everglades National Park, highly valued as both an International Biosphere Reserve and as a United Nations World Heritage Site. Voucher specimens are deposited at the Vascular Plant Herbarium of the University of Florida in Gainesville.

Additional surveys of Taylor Slough found *O. rufipogon* scattered over an area of approximately 0.6 ha. The largest contiguous stand of the weed, approximately 0.02 ha, was growing in a muck pond 40 m north of the Anhinga Trail. Scattered plants were found growing around the pond and in the adjacent surrounding marsh including elongated plants growing in the partial shade of a mixed stand of Coastal Plain Willow, *Salix caroliniana* Michx. and Common Reed, *Phragmites australis* (Cav.) Trin. ex Steud.

Earlier misidentifications of the *O. rufipogon* at this location were due to the similarity of closely related species in this complex of cultivated rice. All of the specimens of Wild Red Rice collected before 27 November 1985 consisted of only the top of the fruiting plant. The inflorescence of *O. rufipogon* is very similar

to *O. sativa*. Having no reason to suspect *O. rufipogon* being in the United States, flowering and fruiting characteristics of these specimens were likely overlooked.

The earliest known recorded specimen is in the Everglades Herbarium, Beard Center, Everglades National Park. This specimen was collected on 11 July 1959 in the Taylor Slough by William G. Atwater and determined by Erdman West as *O. sativa*. It was annotated as *O. sativa* in 1979 by George N. Avery and as *O. rufipogon* by David Hall in 1989.

Additional specimens include: FLORIDA: **Broward Co.**: cultivated at the Research and Education Center of the University of Florida, Fort Lauderdale, from material obtained at the entrance to the Anhinga Trail, Royal Palm Hammock, Everglades National Park, 20 Nov 1989, *Hall 1911* (FLAS). **Dade Co.**: growing in water 3.2 cm deep, Taylor Slough, Everglades National Park, 16 Nov 1961, *P.C. Craighead s.n.* (EVERGLADES NATIONAL PARK HERBARIUM, FLAS); growing in shallow water at the edges of the pond at the entrance to Anhinga Trail, Royal Palm Hammock, Everglades National Park, 27 Nov 1985, *Herndon 1356* (FLAS); shoreline of pond, entrance to Anhinga Trail, Royal Palm Hammock, Everglades National Park, 19 Sep 1988, *Vandiver s.n.* (FLAS); entrance to Anhinga Trail, Royal Palm Hammock, Everglades National Park, near Homestead, 13 Mar 1990, *Hall 1920* (FLAS); 38.5 m W of wooden boardwalk, entrance to Anhinga Trail, Royal Palm Hammock, Everglades National Park, 24 Apr 1990, *Vandiver s.n.* (FLAS); 27.5 m E of bridge, entrance to Anhinga Trail, Royal Palm Hammock, Everglades National Park, 24 Apr 1990, *Vandiver s.n.* (FLAS).

The origin of this introduction is unknown; however, Victor B. Morris a park volunteer in the Everglades National Park, reported that the plant was growing in the area much earlier than 1959. He said that he observed the plant growing in the same area in the mid-1930s (Morris 1990). This area of the Everglades National Park was part of Royal Palm State Park dedicated on 23 November 1916. Morris indicated that numerous introduced species were planted in the Royal Palm State Park during the 1920s in the immediate vicinity of the current Royal Palm Visitor Center.

If *O. rufipogon* has been growing in Taylor Slough since the mid-1930s as the above report indicates, or even since July 1959, it has been slow to extend its range in the area. The limited spread of the infestation is likely due to growth from rhizomes rather than from dispersed seeds. Considering growth habit and area colonized, this particular population of *O. rufipogon* seemingly lies on the perennial side of the perennial-annual continuum described by Oka (1988a). Additional environmental factors such as plant competition could also have had an effect on the growth of the plant, limiting the spread of the infestation. Other weeds introduced into new habitats show slow initial growth for many years followed by an explosive growth stage. Control efforts for *O. rufipogon* have been initiated in Taylor Slough.

ACKNOWLEDGMENTS

We are extremely grateful for the help given to this project by the Florida Department of Agriculture and Consumer Services, Division of Plant Industry,

Gainesville, for personnel support and transportation. We are also grateful for support from the Institute of Food and Agricultural Sciences and the Vascular Plant Herbarium of the University of Florida, Gainesville, and from the U.S. Department of Interior, National Park Service, Everglades National Park, Homestead.

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COFFIN, BARBARA and LEE PFANNMULLER, EDS. 1988. **Minnesota's Endangered Flora and Fauna**. University of Minnesota Press, 2037 University Avenue S.E., Minneapolis, MN 55414. Paper $16.95. 473 pp.

This reference manual examines 300 species that are endangered, threatened or of special concern in Minnesota. The text is well organized. The plant section is divided into three chapters: vascular plants, mosses and lichens. The vertebrate section is divided into four chapters: birds, mammals, amphibians and reptiles and fish. The invertebrate section includes chapters on butterflies, mollusks, tiger beetles and jumping spiders. The plant chapters have the same format. Each chapter list the endangered and threatened species alphabetically by scientific name. This includes a state distribution map and national range map, line drawing, basis for status, preferred habitat and aid to identification. The list of state special concern in an abbreviated format ends the chapters. The animal chapters are similarly organized. The appendices are list of species distribution by county. The index includes scientific and common names. *Dotty Woodson.*

HARAGAN, PATRICIA DALTON. 1991. **Weeds of Kentucky and Adjacent States, A Field Guild.** The University Press of Kentucky, Lexington, Kentucky 40508-4008. Hardbound $29.00. 278 pp.

This manual describes 160 weeds that are a common nuisance to man. The text is organized by color of flower then leaf arrangement. Each plant is described with a line drawing, scientific and common names, earmarks, origin, life cycle, description, distribution, and a brief text. There is a glossary and an index for scientific names and an index for common names. This manual can assist farmers and weed control experts in identifying a target weed in order to control it. *Dotty Woodson.*

SWINK, FLOYD. 1990. **The key to the Vascular Flora of the Northeastern United States and Southeastern Canada**. vi + 513 + 11 unnumbered + xii pages. Plantsmen's Publications, Box 1, Flossmoor, IL 60422. Paper. $21.95 + 3.00 shipping and handling.

The key is unique: it is a long dichotomous key that goes on and on for 513 pages of small type. The area it covers is that of *Gray's Manual* (1950). Nomenclature is of that work, too, but supplemented, when needed, by "more modern" names.

Two sections make up most of the book. The first (pages 1 – 82) is a key to families. The second (83 – 513) has keys to genera of the families and to species of the genera. Used throughout is alphabetical arrangement, the familial and generic names appearing, intermixed, in dictionary-like order. Common names equated to scientific names appear, too, alphabetically. The keys are detailed, so that when one arrives at an identification, one has gone through prose that, collectively, gives a description of the plant. Closing the book are a list of "localized species" not in the key and an excellent glossary.

Floyd Swink has been for many years the senior taxonomist at Morton Arboretum near Chicago. Probably no person in eastern North America (except maybe the late Julian Steyermark) is better acquainted with local flora.

Keying out a plant with *The Key* is a bit tedious, like the same process in *Gray's Manual*, but, with care, one can identify the plant in hand. Anyone with the patience to use *The Key* will find the work most valuable. I recommend it. *John W. Thieret.*

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TRAGUS ROXBURGHII (POACEAE: ZOYSIEAE) NEW TO THE NEW WORLD

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ABSTRACT

Tragus roxburghii Panigr. has recently been identified from a herbarium specimen from the Dominican Republic. This represents the first record of this species in the New World. Four species of *Tragus* are now known to have been introduced into the New World. A key to separate these species is provided, with a description of *T. roxburghii* and its distribution in the New World.

Tragus Haller is a tropical and subtropical genus usually found in disturbed areas and there are seven species recognized worldwide (Clayton and Richardson 1972; Clayton and Renvoize 1986). The genus is recognized by the disarticulation of the spikelets and the short primary branch as one unit, awnless spikelets, minute or absent first glume, and distinct trichomes in longitudinal rows on the second glume, usually overlying the veins. All of the species known in the Americas have been introduced (Anton 1981).

Prior to this report, three species of *Tragus* were known to occur in the New World. *Tragus berteronianus* Schultes occurs in North America, predominately the southwestern U.S. and Mexico, and the West Indies; *T. racemosus* (L.) Allioni occurs sporadically in North America, predominately the southwestern U.S.; and *T. australianus* S.T. Blake which is reported from dry places in Central Argentina (Anton 1981) from the Provinces of La Rioja (*Kurtz 12705,* CORD, K) and San Luis (*A.T. Hunziker 16334,* CORD, K).

Tragus roxburghii Panigr. is the fourth species of this genus to be introduced into the New World. It is found in India, Indochina, China and East Tropical Africa (Anton 1981). This new record was discovered while examining specimens at TAES from the Dominican Republic. The specimen was originally identified as *T. berteronianus,* but I identified it as *T. roxburghii* and verified it with specimens at TAES and US. Specimens were also borrowed from JBSD to determine if other collections had been made.

Tragus roxburghii has long been referred to as *T. biflorus* (Roxburgh) Schultes, which is a superfluous name. Panigrahi (1974) gives a detailed account of the nomenclature history for this taxa and why a new name had to be provided. Since,

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as a result of Panigrahi's study, the authorities of the synonyms are to be cited differently; a brief account of the nomenclatural history is provided.

Tragus biflorus is based on *Lappago biflora*, which was described by Roxburgh in 1820. In addition to the description there is an unpublished illustration of *L. biflora* in the Kew collections [Roxb. Ic. No. 780; CAL, K *(Sealy 1956)*]. This illustration could have been considered the type if Roxburgh had not cited *Phalaris muricata* Forssk., described in 1775, as a direct nomenclatural synonym. This makes *Lappago biflora* a superfluous name for *Phalaris muricata* Forssk. and the type for *P. muricata* must also be treated as the type of *Lappago biflora* (1988 International Code of Botanical Nomenclature, Art. 7.13), since Roxburgh did not clearly indicate a different type. *Lappago biflora* was described from material from the Coromandel Coast of India, but the type for *Phalaris muricata* is from the Sea of Marmora in Turkey and *Tragus biflorus* has not been reported from this type locality. The type for *Phalaris muricata* has not been found in Forsskal's Herbarium at Copenhagen and the description given by Forsskal could be referrable to *Tragus biflorus* or to a poorly observed, depauperate specimen of *T. racemosus*, which is found in Turkey. Thus, Panigrahi (1974) stated that *Phalaris muricata*, at best, should be treated as a synonym of *Tragus racemosus*, and at worst as a name of uncertain application.

Also, the combination *T. muricatus* is already occupied by a name proposed by Moench in 1794, in which Moench cited *Cenchrus racemosus* L. as a direct synonym. This makes *Tragus muricatus* Moench a superfluous name for *T. racemosus* (L.) All.

Schultes in 1824 based his name combination, *T. biflorus*, on *Lappago biflora* Roxb., but still included *Phalaris muricata* as a synonym. Since the basionym, *Lappago biflora* is illegitimate and *Tragus muricatus* is already occupied, this is a legitimate nomen novem. Because Schultes cited *Phalaris muricata* as a synonym, *Tragus biflorus* is actually based on the type of *Phalaris muricata*, and thus belongs to the to the taxon referrable as *Tragus racemosus* and not Roxbourgh's *Lappago biflora*. Consequently, a new name was necessary and provided by Panigrahi (1974). For a more in depth discussion of this complex nomenclatural history see Panigrahi (1974).

A key to the known species of *Tragus* in the New World, along with some spikelet illustrations and a description of *T. roxburghii* are provided. Mature spikelets should be examined when using the key.

KEY TO THE NEW WORLD SPECIES OF *TRAGUS*

1. Second glume 7-veined; clusters of 3 – 6 spikelets ..... *T. racemosus*
1. Second glume 5-veined; clusters of 2 spikelets (rarely 3) 2
   2. The length of the primary branch to the first spikelet is as long as or shorter than the distance between the first and second spikelet (Fig. 1-A); second spikelets 1.8 – 3(4.0) mm long; the primary branch sometimes extends past the second spikelet ..... *T. berteronianus*

2. The length of the primary branch to the first spikelet is longer (up to two times) than the distance between the first and second spikelet (Figs. 1-B and 1-C); second spikelets 3.0 – 4.5 mm long; the primary branch rarely extending past the second spikelet 3
   3. Spikelets of a cluster separated by a distinct internode, (0.2)0.3 – 0.6 mm long (Fig. 1-B); trichomes on second glume of mature spikelets bulbous or thickened at base; inflorescences (2.5)5.0 – 9.0 cm long; leaf blades 3 – 6 mm wide ..... *T. australianus*
   3. Spikelets of a cluster not separated by a distinct internode, 0 – 0.2 mm long, but are attached at more or less the same point on the primary branch (Fig. 1-C); trichomes on second glume of mature spikelets not bulbous or thickened at base, but are slender for their entire length; inflorescences 1 – 5 cm long; leaf blades 2 – 3(4) mm wide ..... *T. roxburghii*

Tragus roxburghii Panigr., Kew Bull. 29(3):496 (1974).—TYPE: INDIA. TAMIL NADU (Madras): Vela Cherry, Jul 1845, *G. Thomson s.n.* (HOLOTYPE: K). Note: The specimen is labelled *'Lappago biflora.'*

Lappago biflora sensu Roxb., Hort. Bengal.:82 (1814), nomen nudum.

Lappago biflora sensu Roxb., Fl. Ind., ed. Carey & Wall. 1:284 (1820), quoad descript., excl. typo.

Tragus biflorus sensu Schultes, Mant. Syst. Veg. 2:205 (1824), nomen novum. Based on *Lappago bifora* sensu Roxburgh.

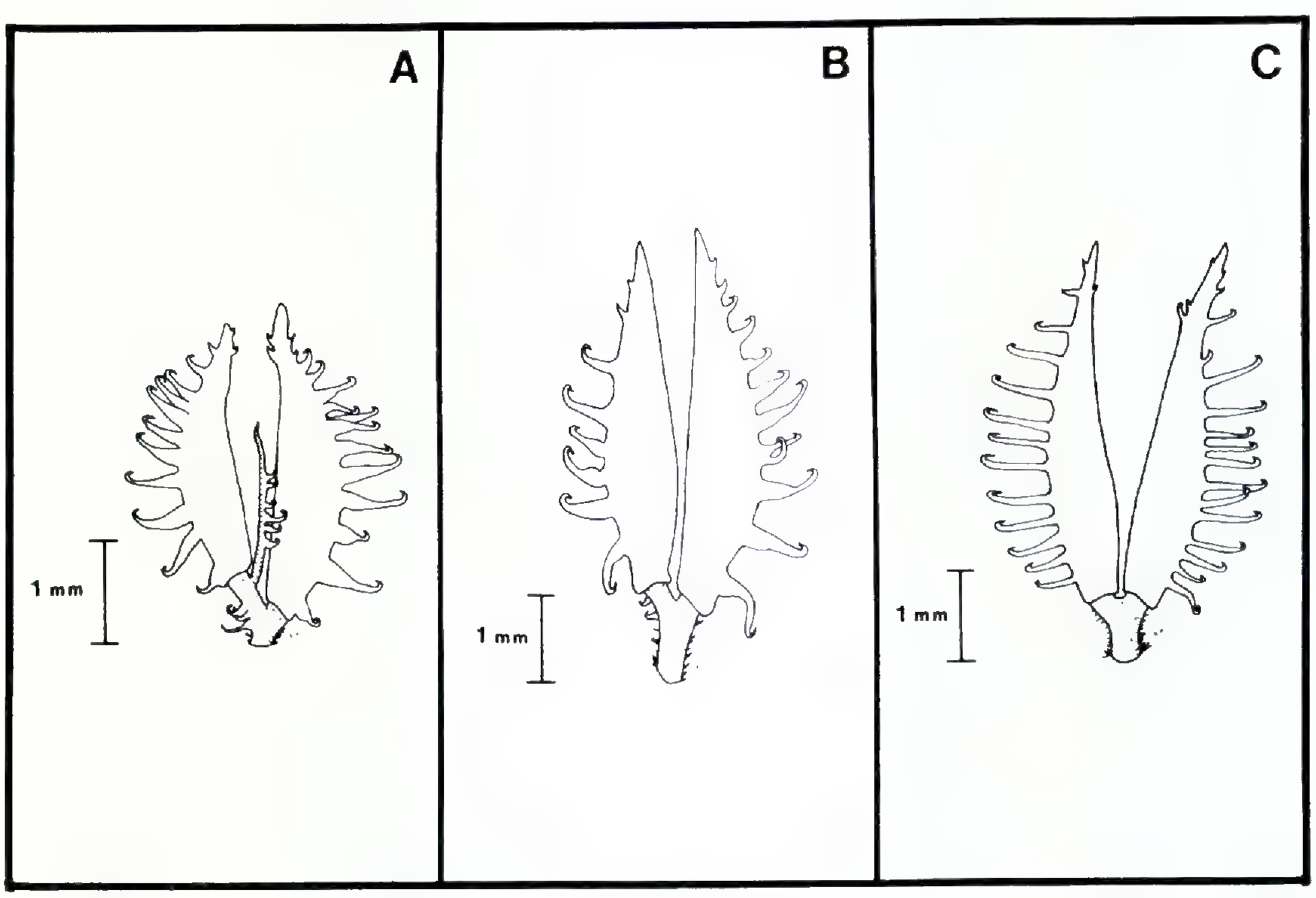

FIG. 1. Diagrammatic illustrations of three *Tragus* species. (A) *T. berteronianus;* (B) *T. australianus;* (C) *T. roxburghii.*

Annual, culms 5.0 – 11.0 (14.0) cm tall, usually spreading; leaf blades 0.5 – 3.0(5.0) cm long and 1.0 – 3.0(4.0) mm wide. *Inflorescence* 1.0 – 5.0 cm long; two spikelets per cluster; 8 – 13(22) clusters per inflorescence; primary branch not extending past the second spikelet; primary branch 0.5 – 0.9 mm long; length of the primary branch to the first spikelet (0.4 – 0.7 mm long) is longer (up to two times) than the internode length between the first and second spikelet (Fig. 1-C); spikelets of cluster not separated by a distinct internode, but attached at more or less the same point on the primary branch. Internode between spikelets 0 – 0.2 mm long. *Spikelets* 3.0 – 4.5 mm long; upper spikelet about same size as first spikelet; *first glume* 0.2 – 0.3 mm long, veinless, membranous; *second glume* 3.0 – 4.5 mm long, 5-veined, trichomes 0.5 – 1.4 mm long, in longitudinal rows (usually over veins) not bulbous or thickened at base, but are slender for their entire length. *Lemma* 2.0 – 2.6 mm long, 3-veined. Palea 1.8 – 2.3 mm long, membranous. *Anthers* 0.4 – 0.6 mm long. *Caryopsis* 1.3 – 1.7 mm long, 0.5 – 0.6 mm wide.

Specimens examined from the New World: DOMINICAN REPUBLIC. **Province of Peravia:** 8.5 km Oeste de Bani en la carretera a Azuai: cerca de Galeon (de Baní) bosque xerofito y espinosa de *Acacia, Calliandra, Prosopis* y Cactaceae, 18° 19'N, 70° 24'O, alt. 100 pies., 18 Nov 1981, Zanoni 18074, Mejia & Pimentel (JBSD, TAES); Las Tablas 15 km de Bani; Proyecto Caprino location de Secretaría de Estado de Agricultura, dry forest with Cactaceae, on sandy soil, with goats grazing, 18° 18'N, 70° 24'W. 1979 and 1980, **Jansen s.n.** (JBSD). NOTE: Mixed sheet: *T. roxburghii* on left and *T. berteronianus* on right and in the fragment packet.

The examination of additional specimens of *Tragus* from the New World, especially from the West Indies, will probably produce further records of this taxon.

ACKNOWLEDGMENTS

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NOMAPHILA STRICTA (ACANTHACEAE), A NEWLY DISCERNED AQUATIC WEED IN TEXAS, AND THE FIRST REPORT FOR NORTH AMERICA

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ABSTRACT

An aquatic weed, *Nomaphila stricta,* new to North America, was discovered in San Felipe Springs, east of Del Rio, Texas, 0.2 mi., Val Verde Co., Texas, where it was well-established and vigorously reproducing by subsurface stolons. The species was apparently recently introduced from the paleotropics and should be carefully monitored by ecologists interested in aquatic ecosystems in the southwestern U.S.A. and adjacent Mexico.

KEYWORDS: *Nomaphila, Hygrophila,* Acanthaceae, aquatic weeds, Texas.

In September of 1991, the junior author, while collecting an aquatic member of the family Asteraceae (*Trichocoronis rivularis* A. Gray), observed and collected an aquatic plant new to him. Indeed, upon further investigation, he was unable to position the species in any North American manual purporting to account for the aquatics of this region (e.g., Correll & Correll 1972; Godfrey & Wooten 1979; etc.). The plant was first thought to be, possibly, an undescribed species of the aquatic genus *Hygrophila* (Acanthaceae), but the peculiar bilabiate corolla, palate lower inner petals, and the exserted, much branched (albeit axillary) inflorescence precluded any close relationship with the North American species of that genus.

Since the plant concerned was abundant and occurred in San Felipe Springs, a well known collecting site visited by numerous botanists (beginning in 1849 with the visit of Charles Wright), it seemed unlikely that the species would not have been collected by yet other workers. Thus, we felt that the species might prove to be an exotic introduction.

The senior author's experience with paleotropical members of the Acanthaceae

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directed him to the genus *Nomaphila,* a segregate from the world wide weedy genus *Hygrophila*. Subsequent research showed the species to be *Nomaphila stricta* (Vahl) Nees, a well known aquatic weed of Malaysia (Backer 1965).

The introduction of this aquatic weed into San Felipe Springs was probably accidental. We surmise that it was dumped into the stream, unintentionally, by someone intent on releasing minnows or "gold fish" into the streams concerned. The proximity of the springs to Lackland United States Air Force Base, Del Rio, Texas, which is home to numerous well travelled service men, often accompanied by their Asian wives, makes this a possibility. Regardless, the plant, which emerges from the water for 30 – 80 cm, always along the stream banks, is well-established on both sides ofthe stream leading from San Felipe Springs. Since the several colonies occur along the banks of San Felipe Springs which soon empties into the Rio Grande River, it is possible that the species might become an obnoxious weed in southern Texas and Mexico. Aquatic ecologists should monitor closely the spread of this taxon; perhaps removal at the present time might seem expedient, since it does appear to compete, in part, with the localized, probably threatened, aquatic species, *Trichocoronis rivularis.*

A brief account on the taxonomy, nomenclature, and a description of the species follows:

Nomaphila stricta (Vahl) Nees in Candolle, Prodr. 11:84. 1844. Based on *Justicia stricta* Vahl, Symb. Bot. II. 6. 1791.

Hygrophila stricta (Nees) Lindau in Engler & Prantl, Naturl, Planzenf. IV. 3b. 297.1895. non *Hygrophila stricta* Hassk., Cat. Bot. Bogor. 148. 1844.

Stoloniferous or rhizomatous aquatic herbs to about 1 m tall. Stems 4-angled, glandular-villous, the nodes thickened. Petioles 2–6 cm long; leaf-blades elliptic oblong, 6 – 15 cm long, 2 – 7 cm wide, acuminate above, obtuse below, with about 16 pairs of parallel secondary veins, entire to subcrenate. Inflorescence axillary, cymose, the branches glandular-hairy. Bracteoles none. Pedicels 4 – 6 mm long. Calyx glandular-hairy, of 5 unequal linear lobes, the posterior ones longer, 7 – 10 mm long, the anterior 2 shorter, ca. 0.6 cm long. Corolla hairy, the tube whitish, ca. 5 mm long, the limb lilac, the upper lip broadly elliptic, ca. 12 mm long, 0.8 mm wide, concave and hood-like, shortly bilobed, the lower ca. 12 mm long, ca. 8 mm wide, broadly elliptic, palate, 3-lobed, the lobes of equal length, the laterals slightly wider than the obliquely plicate, velutinous middle lobe. Stamens 4, included, conspicuously didynamous, the filaments glabrous, the longer ones ca. 6 mm long, the shorter ca. 2 mm long, anther two-celled, ca. 1.5 mm long. Ovary densely glandular-hairy, 2-celled, multiovulate, the style ca. 12 mm long, pubescent, the anterior stigmatic lobe longer.

Nomaphila (Acanthaceae-Contortae-Hygrophileae) is a paleotropical genus, recognized by its axillary cymose inflorescence, glandular-hairy calyx with unequal lobes and the palate, villous to velutinous, lower lip of the corolla. Various authors have often considered it to belong to *Hygrophila* (sect. *Nomaphila*) but in our view

the two differ taxonomically in significant ways. The eglandular calyx with equal lobes, and the axillary clusters (sometimes solitary) of flowers, readily distinguish *Hygrophila* from *Nomaphila.* Up until now there have been no reports of *Nomaphila* becoming naturalized in the Americas, and so its discovery here is of interest. Correspondence with some of the larger herbaria in the U.S.A. revealed only two collections of *Nomphila,* both from indoor cultivation (*Pohl s.n.*, US; and from an aquatic nursery in California, CAS, T. Daniel, pers. comm.). Pohl (pers. comm.) notes that "The original source [of the US collection of *N. stricta*] was undoubtedly Florida, which produces most of the aquarium plants used in the U.S. This species is widespread in the aquarium trade and sells under the name of 'water wisteria', a highly ridiculous term."

Daniel (pers. comm.), after reading our paper, noted that an almost identical situation to that of *Nomaphila* of Texas has occurred "in Florida with *Hygrophila polysperma* (Les & Wunderlin 1981), an aquarium weed that escaped." He further suggested that we check the article concerned "to make certain that the plant identified as *H. polysperma* in Florida is not the same as yours." Our examination of the paper concerned leaves no doubt that the two plants are markedly different.

Hygrophila on the other hand is represented in Texas streams by *H. lacustris* Nees. It should also be noted that if *Nomaphila* were retained in *Hygrophila* it would require a new combination or name, the name *H. stricta* (Nees) Lindau being preempted by the earlier *H. stricta* Hassls., as noted above.

Specimens examined: U.S.A. TEXAS: **Val Verde Co.:** San Felipe Springs, growing in water along E bank ca. 40 m N of the bridge on hwy 90, 13 Sep 1991, *B. Turner 16020* (TEX); same locality, 12 Oct 1991, *B. Turner 16032* (GH, MO, SRSC, TEX).

OLD WORLD: MALAYSIA. **Celebes:** northern central part, on the coast SW of Dongala, *Meijer 10133* (US); **Johore,** Kota Triggi, *Sinclair 8425* (US). INDONESIA. **Timor:** Kumlol, *Sauveur 83* (GH). THAILAND. **Tahsaeh:** Ban Nah Saun, Group 15, *Maxwell 87-62* (GH).

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We are grateful to Mr. Gwylum Lewis of Kew who faxed xeroxes of *Nomaphila stricta* specimens from K, which confirmed the Texas plant's identity, and curators of US and GH for loan of specimens. Mr. T.J. Patterson kindly collected additional material of the species at our request, and is largely responsible for observations as to the distribution discussed. Richard Pohl helped in providing useful information, as noted, and Thomas Daniel reviewed the manuscript including additional helpful comments.

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BOOK REVIEWS

Ownbey, Gerald B. and Thomas Morley. 1991. **Vascular Plants of Minnesota. A Checklist and Atlas.** University of Minnesota Press, 2037 University Avenue Southeast, Minneapolis, MN 55414. Hardbound $39.95 (+$3.00 shipping). 308 pp.

Among publications most useful in the preparation of overall range maps for various species (as mandated, for example, for *Flora of North America*) are state floristic atlases. Since 1980 such works have appeared for Georgia, Louisiana, Utah, and Virginia. Now Minnesota joins this select group.

Minnesota's vascular flora includes 1618 native and 392 introduced species. Like many states, Minnesota can claim to be a meeting ground of broad vegetation types, in this case the prairie and the eastern forest ("conifer zone" and "hardwood forest strip"). (A map of Minnesota vegetation is on page xi.) In the atlas, the Minnesota range of each vascular plant species is shown by a dot in each county of occurrence. Preceding the 209 pages of maps (nine per page; page size 21 × 27.5 cm) is a "Checklist of the vascular plants of Minnesota." Making the list especially useful is the inclusion of literature references under many genera.

Long-time faculty members at the University of Minnesota, Drs. Ownbey and Morley based their atlas on the ca. 97,000 Minnesota specimens in the University of Minnesota Herbarium (MIN) at St. Paul (and "in a few instances, on specimens at other institutions"). Their work will be much consulted both within and outside of their state. *John W. Thieret.*

Shultes, Richard E. and Robert F. Raffauf. 1990. **The Healing Forest: Medicinal and Toxic Plants of Northwest Amazonia.** Dioscorides Press, 9999 SW Wilshire, Portland, Oregon, Price Unknown, 484 pp.

This book, dedicated to the Indians who shared their knowledge of medicinal plants with the authors, is an exquisite and valuable text dealing with the toxic and medicinal plants of the northwest Amazon. The authors, understanding that many readers would not be pure ethnobotanists or taxonomic botanists, have arranged and discussed selected plants in a very user-friendly way. Plant families are arranged alphabetically without regard to phylogenetic relationships. Genera within families and species within genera are similarly arranged.

A full citation of the place and date of publication of each binomial is provided. Generally, synonyms are not given and, in some cases, older more well known binomials are retained in place of some recently changed unfamiliar names. Indigenous names of plants are provided with their tribal identifications. These aboriginal names collected by the authors are written in a simple orthography and a pronunciation key is provided.

A brief introduction describing the geographic range, general chemical constituency (when known), and medicinal uses is provided for each genera. Additionally, specific medical of toxin applications are presented for each species discussed.

Of the 1516 species (in 145 families and 594 genera) listed in this book, at least 50% have had little or no investigation. This book collectively represents nearly half a century of field research by the authors. The text clearly meets its stated goals of emphasizing the importance of ethnobotanical conservation and focusing attention on the biochemicals of this region that may have value to modern medicine and industry. *Joe Kuban.*

NOTES ON *CYPERUS* AND *KYLLINGA* (CYPERACEAE) IN MISSISSIPPI WITH RECORDS OF SIX SPECIES NEW TO THE STATE

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ABSTRACT

Field and herbarium studies have yielded six species of *Cyperus* (Cyperaceae) new to Mississippi, U.S.A.: *Cyperus aggregatus, C. difformis, C. ovatus, C. oxylepis, C. pilosus,* and *C. thyrsiflorus*. At least one of these, *C. difformis*, has potential to be a serious threat as an agricultural weed. Additionally, significant range extensions for other species of *Cyperus* and *Kyllinga* are reported. Locality and habitat data are provided for all species reported.

INTRODUCTION

While preparing a synoptical treatment of *Cyperus* and *Kyllinga* as a contribution to the revitalized Flora of Mississippi Project, under the direction of Dr. Sidney McDaniel, Mississippi State University and Institute for Botanical Exploration, we have examined specimens in the following herbaria: IBE, MISS, MISSA, SWSL, VDB, VSC, personal herbarium of Charles T. Bryson (ctb), herbarium of the Mississippi Museum of Natural Science, and herbarium of the University of Southern Mississippi.

The only comprehensive list of the vascular flora of Mississippi was published in 1921 by Lowe. Since this work was published, knowledge of the flora of Mississippi has expanded greatly. However, Lowe's work, although outdated, must necessarily serve as a base line for general floristic work in Mississippi. Other references dealing exclusively with *Cyperus* and *Kyllinga,* which we have used as sources for distributional data are Kükenthal (1935-1936), McGivney (1938), Corcoran (1941), and Horvat (1941).

Intensive field work in southern Mississippi during August and September 1991 has yielded four *Cyperus* species, *C. aggregatus, C. difformis, C. oxylepis* and *C. pilosus,* previously unknown in Mississippi. Moreover, we have found specimens of two additional species, *Cyperus ovatus* and *C. thyrsiflorus,* which have not been previously reported from Mississippi.

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NEW STATE RECORDS

Cyperus aggregatus (Willd.) Endl. is a neotropical weed, apparently introduced into the southeastern United States. It has been called *C. huarmensis* (H.B.K.) M.C. Johnston, *C. cayenennsis* (Lam.) Britton, and *C. flavus* (Vahl) Nees. However, Tucker (1985) determined *C. aggregatus* to be the correct name. In southeastern United States, it is known from Florida (Clewell 1985), Louisiana (Horvat 1941), and Texas (Correll & Johnston 1970). In Pensacola, Florida, *C. aggregatus* has been observed to be an aggressive weed of open sandy lots (*Carter 8075*, 8 Aug 1989, IBE, MO, SWSL, VDB, VSC). Following are the first records of this species from Mississippi.

Collection data. U.S.A. MISSISSIPPI. **Stone Co.**: W of Wiggins, 1.2 mi N of jct of hwys US 49 and MS 26 (3 mi S of county line), W side of Hwy US 49 at roadside park, sandy soil on ridge top, T2S R12W SW1/4 S4, 16 Sep 1991, *Bryson & Newton 10982* (BRIT/SMU, ctb, IBE, MICH, MISS, MISSA, MO, NLU, SWSL, TAES, VDB, VSC); SW of Wiggins, 0.4 mi S jct hwys US 49 and MS 26, W of hwy US 49, T2S R12W S25, open sandy slope, 16 Sep 1991, *Bryson & Newton 10988* (ctb, IBE, SWSL, VSC); just NE of Red Creek jct with hwy US 49 (N of hwy US 49 exit to Perkinston), T3S R11W NW1/4 S18, open to partially shaded sandy soil above Red Creek, 16 Sep 1991, *Bryson & Newton 11001* (ctb, IBE, SWSL, VSC).

Cyperus difformis L. is ranked by Holm et al. (1991) as the thirty-second most important weed pest in the world. It is wide-ranging and occurs in southern Europe, Asia, Central America, North America, Australia, and the Pacific Islands (Kükenthal 1935 – 36). It is a particularly vexatious pest because of its rapid generation time and high reproductive potential (Holm et al. 1991). In the United States, *C. difformis* has been known from Virginia since 1934 and is a troublesome weed of rice in California (Bryson 1984). It is also known from New Mexico (McGivney 1938), Texas (Lipscomb 1980), Louisiana (Thieret 1964), Alabama (Kral 1973), Florida (Burkhalter 1985), Tennessee (Webb & Dennis 1981), North Carolina (Tyndall 1983), and Pennsylvania (Smith 1986). Its occurrence, range expansion, and habitat requirements in the United States have been documented by Lipscomb (1980) and Tyndall (1983). Following are data for the first collections of *Cyperus difformis* from Mississippi.

Collection data. U.S.A. MISSISSIPPI. **Jackson Co.**: Pascagoula, 1 mi S by hwy MS 611 from jct with hwy US 90 and MS 63, vicinity of Bayou Casotte industrial development area, open sandy ditch and low area between railroad track and hwy 611 across from and N of Consolidated Pipe & Supply, T8S R5W S4&5, 16 Sep 1991, *Bryson & Newton 11058* (BRIT/SMU, ctb, DSC, IBE, MICH, MISS, MISS, MO, SWSL, TAES, VDB, VSC, additional specimens to be distributed later). **George Co.**: E of Lucedale, 2.3 mi E of jct hwys MS 26 & 63, 1.8 mi S jct hwys US 98 & MS 63, T1S R6W S1/2 S26, 17 Sep 1991, *Bryson & Newton 11076* (BRIT/SMU, ctb, DSC, IBE, MICH, MISS, MISS, MO, SWSL, TAES, VDB, VSC, additional specimens to be distributed later).

Cyperus ovatus Baldwin (= *C. pollardii* Britton in Small) is closely allied with *C. retrorsus* Chapman. All collections of *C. ovatus* from Mississippi, which were

made prior to ours, were identified as *C. retrorsus. Cyperus ovatus* can be readily distinguished from *C. retrorsus* by its yellowish ascending scales. *Cyperus ovatus* is primarily a species of peaty sands in coastal flatwoods. It occurs along disturbed margins of ponds, edges of saltmarshes and streams, in bogs and pineland savannas, and in ditches. It is distributed throughout Florida and northward in the outer Atlantic coastal plain into North Carolina and westward along the Gulf coast into Louisiana (Carter, in prep.).

Specimens examined. U.S.A. MISSISSIPPI. **George Co.:** Lucedale, 16 May 1954, *Demaree 35195* (USF). *Harrison Co.:* 1 block N of main intersection in Cuevas, 11 Sep 1979, *Carter 2105* (ctb, IBE, VDB, VSC); N Gulfport, 4 mi N of Gulf of Mexico, along hwy US 49, 12 Sep 1979, *Carter 2123* (ctb, IBE, MO, VDB, VSC); just S of Woolmarket at interchange of hwys US I-10 and MS 67, 27 Aug 1991, *Carter & Bryson 9054* (ctb, IBE, VSC). **Jackson Co.:** Petit Bois Island, 4 Aug 1953, *Demaree 33523* (USF); Ocean Springs, ca Gulf Coast Research Lab, 17 Sep 1970, *Jones et al 20470* (MISS, VDB); 7 mi E Moss Point, S hwy US 90, along Franklin Creek Rd, 24 Jul 1989, *Bryson 8691* (ctb, VSC); Ocean Springs, recently disturbed vacant lot just NW of corner of hwy US 90 and Washington Street, 27 Aug 1991, *Carter & Bryson 9069* (ctb, IBE, MICH, MISS, MO, SWSL, TAES, VDB, VSC); Ocean Springs, edge of saltmarsh at entrance to Gulf Coast Research Laboratory, S end of Halstead Rd, 27 Aug 1991, *Carter & Bryson 9079* (ctb, IBE, MICH, MO, SWSL, TAES, VDB, VSC). **Pearl River Co.:** Picayune, intersection of hwys US I-59 and MS 43, just W of I-59, 26 Aug 1991, *Carter & Bryson 8998* (ctb, IBE, MICH, MISS, MISSA, MO, NLU, NYS, SWSL, TAES, VDB, VSC); ditch along hwy US I-59 pull off, 2.5 mi N of Carriere, 26 Aug 1991, *Carter & Bryson 9010* (IBE, MICH, VSC). **Stone Co.:** roadside SE Perkinston, hwy US 49, 16 Sep 1991, *Bryson & Newton 11015* (ctb, VSC).

Cyperus oxylepis Nees ex Steudel is readily distinguished by its viscid herbage. Moreover, it is distinctively and pleasantly aromatic, the fragrance being somewhat like that of cured juniper wood. The only other Cyperus with which it is likely to be confused is related *Cyperus elegans* L. The following key distinguishes these two species.

Scales grayish brown; achenes obovoid, 0.7 – 1.0 mm broad, black ..... *Cyperus elegans*
Scales golden yellow; achenes oblong, ca 0.5 mm broad, brown ..... *Cyperus oxylepis*

Cyperus oxylepis is distributed primarily in South America and the Caribbean (Kükenthal 1935 – 1936, p. 167). It is apparently introduced into North America. In the United States *C. oxylepis* occurs along the Gulf and southern Atlantic coasts in disturbed fine-textured soils with shell deposits, such as fill and dredge areas in vicinity of ports. It was first reported in the United States from Texas by O'Neill (1938b) and, subsequently, has been reported from Louisiana (Thieret 1964) and South Carolina (Tucker 1987, p. 402). Recently, it has been discovered for the first time in Mississippi.

At the Mississippi site, *Cyperus oxylepis* was found to be locally abundant in a heavily disturbed fill area along the coast. The population consisted of more than 1000 plants confined to an area of about 200 acres. Collection data for *C. oxylepis* in Mississippi follow.

Collection data. U.S.A. MISSISSIPPI. **Jackson Co.:** Pascagoula, port development E of city in vicinity of Bayou Casotte, S of city animal shelter at S end of Louise Street, 0.4 mi S of Washington Avenue, heavily disturbed fill area, clay with oyster shell fragments, 27 Aug 1991, *Carter & Bryson 9061* (BRIT/SMU, ctb, DSC, IBE, MICH, MISS, MISSA, MO, NLU, NY, NYS, SWSL, TAES, US, VDB, VSC, additional specimens to be distributed later).

Cyperus pilosus Vahl is a weed of tropical or subtropical regions of Asia, Australia, and West Africa (Kükenthal 1935–1936, p. 93–94) and is a common weed of rice fields in Asia (McGivney 1938). It was apparently introduced into North America from the Old World and was first reported in the United States from Louisiana by (O'Neill 1938a). Subsequently, it was reported from western Florida by Burkhalter (1985), and in 1989 it was relocated in Tangipahoa Parish, Louisiana (*Carter 8112,* IBE, MO, NLU, SMU, SWSL, VDB, VSC).

Cyperus pilosus is unlike any other North American *Cyperus* and can be readily distinguished in the field by its rhizomatous habit; wing-angled, scabrid culm; and open inflorescence with hispid rhachides and pale scales. *Cyperus pilosus* has not been previously reported from Mississippi. Following is the first report of this species from the state.

Collection data. U.S.A. MISSISSIPPI. **Jackson Co.:** Ocean Springs, recently disturbed vacant lot just NW of corner of hwy US 90 and Washington Street, 27 Aug 1991, *Bryson & Carter 10880* (ctb, IBE, MICH, MISS, MISSA, MO, NLU, NY, NYS, SWSL, TAES, US, VDB, VSC).

Cyperus thyrsiflorus Schlechtend. & Cham. is rare to infrequent in southeastern United States. It is known from Florida, southern Alabama, Louisiana, Texas, the Caribbean, Mexico, and South America (Horvat 1941). It is closely related to *Cyperus tetragonus* Elliott but differs from this species in its narrower leaves and spikelets. *Cyperus thyrsiflorus* has not been previously reported from Mississippi. Following is collection data from a specimen found at MISSA, which has been determined to be *C. thyrsiflorus.*

Collection data. U.S.A. MISSISSIPPI. **Adams Co.:** loessal bluffs, 1 mi N of Doloroso, frequent on steep mesic slope with mixed hardwood cover, 28 Jun 1956, *Ray 6584* (MISSA).

OTHER NOTEWORTHY COLLECTIONS

Cyperus lancastriensis Porter in Gray was first reported from Mississippi by Morris (1988). This report was based upon a collection from Grenada County in northwestern Mississippi. Subsequently, it has been found in two additional counties in the northeastern quadrant of the state. Following are data on these more recent collections of *C. lancastriensis* from Mississippi.

Collection data. U.S.A. MISSISSIPPI. **Lee Co.:** NE Tupelo, sandy hilltop E of Saltillo Road between Tupelo and Saltillo, 21 Aug 1987, *Bryson 6953* (ctb). **Tishomingo Co.:** just N of Tishomingo State Park, along open, sandy roadside on Natchez Trace Parkway, 25 Jul 1987, *Bryson 6674* (ctb).

Cyperus retroflexus Buckley [= *C. uniflorus* Torrey & Hooker, auct. non

Thunberg (fide G.C. Tucker 1987)] was first reported from Mississippi by Carter et al. (1987) and recently has been reported new to Missouri (Carter & Bryson 1991). *Cyperus retroflexus* is a weed of open sandy or sandy loam soils and is often associated with *Cyperus retrorsus* and *C. croceus* Vahl. Since the initial report from Bolivar and Scott counties, Mississippi, it has been located in two additional and widely separated counties in northern Mississippi, one on the western side of the state and the other on the eastern side. Data for these additional collections follow.

Collection data. U.S.A. MISSISSIPPI. **Oktibbeha Co.:** Plant Science Farm, Mississippi State University, S of hwy US 82, on edge of field, 5 Sep 1990, *Bryson 10324* (ctb, VSC). **Washington Co.:** W of Greenville, across Archer Island, 0.5 mi N of state line, T18N R9W S/2 S8, sand blows and low sandy ridges above Mississippi River, open areas along edge of bottomland hardwood forest, 20 Sep 1990, *Bryson 10430* (ctb, VSC).

Kyllinga brevifolia Rottb. is a pantropical weed (Tucker 1984). Distribution maps in Delahoussaye and Thieret (1967) show only two dots outside of the outer Gulf and Atlantic coastal plains in the southeastern United States. One of these is in southeastern Oklahoma, and the other is in north central North Carolina. In Mississippi, *K. brevifolia* is occasional to common in the coastal counties. Elsewhere in southern Mississippi, it is an occasional pest in *Stenotaphrum secundatum* (Walt.) Kuntze (St. Augustine grass) on turf farms and in lawns. Previously, it was not known from northern Mississippi. Recently, it has been found growing in Washington County, Mississippi, in a lawn of St. Augustine grass and a mulched flower bed. It apparently was introduced into these sites when the lawn was established from turf and when the flower beds were mulched with pine-bark and nuggets.

Collection data. U.S.A. MISSISSIPPI. **Washington Co.:** Leland, Cypress Street, weed in lawn of St. Augustine grass, 13 Aug 1991, *Bryson 10824* (BRIT/SMU, ctb, IBE, MICH, MISS, MO, NLU, NYS, SWSL, TAES, VDB, VSC); Leland, weed in flower bed mulched with pine bark, Willeroy Street, Presbyterian Church, 14 Sep 1991, *Bryson 10973* (ctb, VSC).

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NOTES ON NOTEWORTHY RECORDS OF *CAREX* (CYPERACEAE) FROM THE SOUTHEASTERN UNITED STATES

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ABSTRACT

Field work in the southeastern United States has resulted in a number of noteworthy *Carex* records. *Carex conjuncta, C. ormostachya,* and *C. vestita* are reported new to Delaware, Virginia, and Alabama, respectively. *Carex austrina, C. brevior, C. bullata, C. gravida, C. hyalina, C. mitchelliana, C. molesta, C. oklahomensis, C. oligocarpa,* and *C. torta* are reported new to Mississippi. *Carex oxylepis* var. *pubescens* is reported new to Alabama and Mississippi. Also, additional range extensions are presented for *C. barrattii, C. bromoides, C. elliottii, C. hyalina, C. jamesii, C. meadii, C. microdonta, C. mitchelli-ana, C. picta, C. seorsa, C. socialis, C. stricta,* and *C. willdenowii* in several southern states.

INTRODUCTION

The genus *Carex* (Cyperaceae) is an important element of the flora of the southeastern United States. Many areas of the Southeast remain unexplored or poorly explored for *Carex* (Naczi & Bryson 1990). This paper reports occurrence, habitats, and distribution of twenty-five native *Carex* from Delaware south and west to Mississippi and Arkansas. These noteworthy collections include new state and county records, range extensions, and rediscoveries of populations known from historic collections.

The terminology of physiographic provinces and their sections follows Lowe (1921), Fenneman (1938), and Pirkle & Yoho (1977). Herbarium abbreviations follow Holmgren et al. (1990) except ctb, MMNS, and USMH (Charles T. Bryson personal herbarium, Mississippi Museum of Natural Science, Jackson, MS, and The University of Southern Mississippi, Hattiesburg, MS, respectively).

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1. **Carex austrina** (Small) Mack.

MISSISSIPPI. **Hinds Co.:** E of Clinton, N of hwy US 80, 28 Jul 1990, *Bryson 10137* (ctb). Lee Co.: 0.25 mi SW of Tupelo, 29 May 1982, *Bryson 3387* (ctb). **Newton Co.:** 4.2 mi E of Newton, 6 Jun 1982, *Bryson 3406* (ctb); 4 mi E of Newton, 6 Jun 1987, *Bryson 5890* (ctb); 4.5 mi E Newton, 13 Apr 1990, *Bryson 8830 & Bryson* (ctb). **Oktibbeha Co.:** 1 mi NE of Adaton, 27 Apr 1974, *Bryson 424* (ctb); 6.5 mi WNW of Starkville, 24 Apr 1982, *Bryson 3206* (ctb, IBE); E of Mississippi State University, 4 Jun 1986, *Bryson 4409* (ctb); 0.5 mi NW of Sturgis, "Hannah Hill", 16 May 1989, *Bryson 8601* (ctb, IBE, MICH, MMNS, NLU, SWSL, TAES, USMH, VDB, VSC). **Scott Co.:** Bald Hill, 10 May 1991, *Bryson 10807 & Weiland* (ctb).

Carex austrina is known from sunny sites on calcareous soils from Missouri and eastern Kansas to Arkansas and Texas (Mackenzie 1931; Steyermark 1963). Our specimens represent the first collections from Mississippi. These collections are from open, grassy areas on sandy to silty loam soils in the Black Prairie, Jackson Prairie, and Central Hills regions. *Carex longii* Mack. was a common associate with *C. austrina* at each of these locations.

2. **Carex barrattii** Schwein. & Torr.

ALABAMA. **DeKalb Co.:** W of Chavies, 27 Apr 1936, *Svenson 7690* (MO, PH); Lookout Mtn., 10 May 1990, *McDaniel 30581A and Bixler* (ctb, IBE); Lookout Mtn., 7 May 1991, *Naczi 2889* (ctb, MICH, PH, TRTE, VDB).

Ranging from Connecticut south to Alabama (Fernald 1950), *C. barrattii* is a rare and local sedge of openings in wet, acid woodlands. For over fifty years, Svenson's collection from Sand Mountain was the only station known from Alabama and the southernmost. We have rediscovered this taxon in Alabama and extended its known geographic range southward by about 25 km (15 mi) to Lookout Mountain. Like Svenson's locality, both of our collections are from the Cumberland Plateau section of the Appalachian Plateaus Physiographic Province. At both of our sites, *C. barrattii* formed large colonies at the edge of lightly shaded, shallow pools in *Pinus-Quercus-Acer rubrum* L.-*Liquidambar styraciflua* L. woods.

3. **Carex brevior** (Dewey) Mack. ex Lunell

MISSISSIPPI. **Bolivar Co.:** 2 mi W of Scott, 27 Apr 1992, *Bryson 11416 & Newton* (ctb, IBE, MICH, MMNS, NLU, SWSL, TAES, VDB, VSC, additional duplicates to be distributed later). **Coahoma Co.:** between Tutwiler and Rome along hwy US 49W, 4 May 1988, *Bryson 7492* (ctb), *Bryson 7568* (ctb, IBE), *Bryson 7574* (ctb); Hopson, 24 Apr 1992, *Bryson 11412 & Newton* (ctb, IBE, MICH, NLU, SWSL, VDB). **Kemper Co.:** S of Wahalak Creek at jct. with hwy US 45, 15 May 1989, *Bryson 8572 & Naczi* (ctb). **Oktibbeha Co.:** Mississippi State University, 11 May 1982, *Bryson 3285* (ctb); 1.2 mi E of Mississippi State University, 22 Apr 1987, *Bryson 5391* (ctb, IBE, MICH, MMNS, NLU, VDB); 0.5 mi NW of Sturgis, "Hannah Hill", 16 May 1989, *Bryson 8600* (BRIT/SMU, ctb, GA, IBE, MICH, MMNS, NLU, SWSL, TAES, VDB, VSC). **Panola Co.:** ca. 11.4 mi W of Batesville, 4 May 1988, *Bryson 7562* (ctb). **Tallahatchie Co.:** S of Tutwiler, 4 May 1988, *Bryson 7525* (ctb, GA, IBE, MICH, MMNS, NLU, SWSL, TAES, VDB, VSC), 11 Apr 1990, *Bryson 8779 & Newton* (ctb, IBE, MICH, SWSL). **Tunica Co.:** ca. 11 mi S of Tunica, 24 Apr 1992, *Bryson 11411 & Newton* (ctb, IBE, MICH, NLU, TAES, VDB, VSC).

Carex brevior is known from open areas in dry, calcareous to neutral soils from Quebec and Maine to British Columbia southward to the District of Columbia, Tennessee, Texas, New Mexico, and Oregon (Mackenzie 1931) and Mexico (Hermann 1974). Our collections are the first records of *C. brevior* from Mississippi. In Coahoma, Panola, and Tallahatchie counties, it was found along roadsides and along a section of abandoned Illinois Central Gulf railroad in association with *Montia linearis* (Dougl. ex Hook.) Greene, which was recently reported as new to Mississippi (Rabeler & Bryson 1990). At these sites and the Bolivar, Oktibbeha and Tunica County locations, *Bromus catharticus* Vahl, *Festuca pratensis* Huds., and *Lolium multiflorum* Lam. are common associates. It is possible that *C. brevior* was introduced into Mississippi when pastureland and roadsides were seeded with these grasses earlier this century. These populations are from the Delta and Central Hills regions.

4. **Carex bromoides** Willd. subsp. bromoides

MISSISSIPPI. **Amite Co.:** Cavin Farm, 28 Mar 1991, *Rosso 91-132* (ctb). **Jasper Co.:** ca. 5 mi NW of Montrose, 21 Mar 1992, *McDaniel 31361* (IBE, duplicates to be distributed). **Rankin Co.:** ca. 8 mi N of Brandon, 18 May 1990, *Naczi 2432* (ctb, MICH, PH, US, VDB). **Walthall Co.:** N of Tylertown, 12 Apr 1991, *Bryson 10713* (BRIT/SMU, ctb, GA, IBE, MICH, MMNS, NLU, SWSL, TAES, VDB, VSC).

Few localities are known for *C. bromoides* subsp. *bromoides* in Mississippi (Naczi 1990). Our collections are the first for southern Mississippi, new county records, and all localities are in the Longleaf Pine Belt and Jackson Prairie regions.

5. **Carex bullata** Willd.

MISSISSIPPI. **Tishomingo Co.:** 3 mi W of Mt. Woodall, 12 May 1973, *Bryson 223C* (ctb).

Carex bullata is known from swampy meadows from Nova Scotia to Georgia (Mackenzie 1931). This collection represents the first record of *C. bullata* from Mississippi. *Carex bullata* was uncommon at this site and grew in a sandy, sphagnous bog. The collection is from the Tennessee River Hills Region.

6. **Carex conjuncta** Boott

DELAWARE. **New Castle Co.:** 1.6 mi NW of Talleyville along Brandywine Creek, 12 Jun 1990, *Naczi 2561* (ctb, DOV, MICH, PH).

Carex conjuncta is known from New York and New Jersey to South Dakota and southward to Virginia, Tennessee, Missouri, and Kansas (Mackenzie 1931; Steyermark 1963). *Carex conjuncta* was common at this site, a Piedmont floodplain meadow where it grew in association with *C. amphibola* Steud., *C. blanda* Dewey, *C. caroliniana* Schwein., *C. davisii* Schwein. & Torr., *C. grisea* Wahlenb., and *C. squarrosa* L. in light shade near the edge of a forest. Apparently, this is the first collection of *C. conjuncta* from Delaware, since neither Mackenzie (1931) nor Tatnall (1946) reported it from the state.

7. **Carex elliottii** Schwein. & Torr.

GEORGIA. **Berrien Co.**: near Alapaha, 5 May 1904, *Harper 2190* (MO). **Emanuel Co.**: near Graymont, 6 Jun 1901, *Harper 818* (MO). **Richmond Co.**: Augusta, May 1869, *Canby s.n.* (MICH, MO). **Taylor Co.**: ca. 5 mi NE of Butler, 23 May 1987, *Naczi 1625* (ctb, GA, MICH, US, VSC).

Carex elliottii is an uncommon sedge of wet, acid soil with a small geographic range: the Coastal Plain of North Carolina, South Carolina, Georgia, Florida, and Alabama (Mackenzie 1935; Radford et al. 1968; Godfrey & Wooten 1979). Jones & Coile (1988) map *C. elliottii* from only Marion County, Georgia. However, the type locality is Chatham County (Schweinitz & Torrey 1825). We cite recent and historic records from four additional counties that document the widespread, but scattered, occurrence of *C. elliottii* on the Coastal Plain of Georgia. In Taylor County, *C. elliottii* was infrequent in a sunny, sphagnous seep with *C. atlantica* L.H. Bailey subsp. *atlantica*.

8. **Carex gravida** L. Bailey

MISSISSIPPI. **Prentiss Co.**: NE of New Site, 10 May 1985, *Bryson 3854 & Bryson & Bryson* (ctb).

Carex gravida is known from Ontario, Manitoba, and North Dakota to Wyoming and southward to Ohio, Indiana, Illinois, Missouri, and Kansas (Catling 1987; Mackenzie 1931; Steyermark 1963). This collection represents the first record of this taxon from Mississippi where it grew along the edge of a *Carya-Quercus* woods in the Tennessee River Hills Region.

9. **Carex hyalina** Boott

ARKANSAS. **St. Francis Co.**: Linden Island, S of Madison, 29 May 1960, *McDaniel 1872* (IBE). MISSISSIPPI. **Coahoma Co.**: 2.5 mi NW of Lula, 2 May 1971, *McDaniel 15046* (IBE), 24 Apr 1992, *Bryson 11381 & Newton* (BRIT/SMU, ctb, IBE, MICH, MO, NLU, SWSL, TAES, USMH, VDB, VSC, additional duplicates to be distributed). **Tunica Co.**: ca. 5 mi S of Tunica, 24 Apr 1992, *Bryson 11389 & Newton* (ctb, IBE, MICH, NLU, SWSL, TAES, VDB); ca. 4 mi SE of Tunica, 24 Apr 1992, *Bryson 11396 & Neuton* (BRIT/SMU, ctb, IBE, MICH, MO, NLU, SWSL, TAES, VDB, VSC, additional duplicates to be distributed later); ca. 11 mi S of Tunica, 24 Apr 1992, *Bryson 11408 & Newton* (BRIT/SMU, ctb, IBE, MICH, NLU, TAES, VDB, VSC).

Carex hyalina is known from very few counties in Arkansas, Oklahoma, and Texas (Correll & Johnston 1970; Orzell & Bridges 1987; Naczi & Bryson 1990). The Mississippi records are the first report for the state and these populations are only a few miles from the St. Francis County population. The St. Francis County collection represents a new county record for Arkansas and is near the recently reported Jackson County, Arkansas location (Naczi & Bryson 1990). Each of these collections are from the Delta Region. In Mississippi, *C. hyalina* grew in association with *C. cherokeensis* Schwein., *C. corrugata* Fern., and *C. socialis* Mohlenbr. & Schwegm. under a *Celtis laevigata* Willd.-*Diospyros virginiana* L.-*Liquidambar*

styraciflua -*Quercus nigra* L.- *Q. phellos* L.- *Q. similis* Ashe-*Q. texana* Buckl.-*Ulmus americana* L.-*U. crassifolia* Nutt. woods.

10. **Carex jamesii** Schwein.

MISSISSIPPI. **Tunica Co.:** ca. 11 mi S of Tunica, 24 Apr 1992, *Bryson 11400 & Newton* (ctb, IBE, MICH, MO, SWSL, VDB).

Carex jamesii is rare in Mississippi. Previously, it was known from four counties in the state (Naczi & Bryson 1990). Our specimen represents the first collection of *C. jamesii* from the Delta Region.

11. **Carex meadii** Dewey

MISSISSIPPI. **Chickasaw Co.:** 0.7 mi E of Trebloc, 14 May 1992, *Bryson 11549* (ctb, IBE, MICH). Scott Co.: Harold Prairie Hill, 10 May 1991, *Bryson 10769 & Weiland* (ctb, IBE, MICH). **Yalobusha Co.:** 6 mi NE of Oakland, 9 Apr 1991, *Bryson 10618* (ctb, IBE, MICH, NLU).

Like previous records of *C. meadii* in Mississippi (Bryson 1984; Naczi & Bryson 1990), the Chickasaw and Scott County populations grew in a narrow band of marl soil below the crest of a prairie hilltop. The Yalobusha County population is the first from the Central Hills Region. At this site, *C. meadii* was found on a clay soil near the crest of a hill in association with a *Carya-Juniperus virginiana* - Q*uercus-Ulmus* woods. This population is unlike all others known in Mississippi because it grew in a lightly shaded area and was growing over chalk within the Jackson or Black Prairie regions.

12. **Carex microdonta** Torr. & Hook.

MISSISSIPPI. **Chickasaw Co.:** 2.4 mi NW of Okolona, 14 May 1992, *Bryson 11576* (ctb, IBE, MICH). **Oktibbeha Co.:** 1.5 mi S of Sessums, 2 May 1991, *McDaniel 31046* (IBE, duplicates to be distributed).

These records represent new county records of *C. microdonta* for Mississippi. As with previous *C. microdonta* records from Mississippi, these populations are from clay or marl soils (Naczi & Bryson 1990). These populations are in the Black Prairie Region.

13. **Carex mitchelliana** M.A. Curtis

ALABAMA. **Hale Co.:** Payne Lk., Talladega National Forest, 30 Apr 1987, *Bryson 5571* (ctb). **Monroe Co.:** N of Midway, 28 Apr 1991, *Naczi 2821* (ctb, MICH, VDB). MISSISSIPPI. **Tishomingo Co.:** Tishomingo State Park, 6 May 1974, *Bryson 613* (ctb), 24 May 1983, *Bryson 3566* (ctb, MICH). **Winston Co.:** 8 mi NE of Louisville, 22 May 1982, *Bryson 3326* (MICH).

Carex mitchelliana is an uncommon sedge that usually grows in lightly shaded, wet, acid soil. At each of the localities cited above, it occurred along small streams through deciduous forests (although, with a few pines at the Tishomingo County locality). Our collections are from springs and seeps in ra-vines just upslope from the streams. At the Hale and Monroe County sites, *C. mitchelliana* grew in

association with *C. atlantica* subsp. *atlantica, C. debilis* Michx., *C. styloflexa* Buckl., and *C. venusta* Dewey. Bruederle et al. (1989) map *C. mitchelli-ana* from Massachusetts south to Florida and west to southwestern Tennessee and northern and eastern Alabama. Our collections add a new state (Mississippi) and new Alabama counties (Hale and Monroe) to its previously known distribution.

14. **Carex molesta** Mack. ex Bright

MISSISSIPPI. **Issaquena Co.:** 1 mi N of Mayersville, 5 May 1986, *Bryson 4253* (ctb). Lee Co.: 0.25 mi SW of Tupelo, 11 May 1973, *Bryson 214* (ctb); 0.5 mi SW of Tupelo, 24 May 1980, *Bryson 3046* (ctb, IBE). **Oktibbeha Co.:** 0.5 mi W Starkville, 20 May 1977, *Bryson 1684* (ctb); 2 mi NE of Clayton Village, 2 May 1981, *Bryson 3145* (ctb); 1 mi E of Mississippi State University, 16 May 1984, *Bryson 3641* (ctb), 16 May 1990, *Bryson 9862 & S.&G. Jones* (ctb, IBE, MICH, SWSL), 16 May 1990, *S.&G. Jones 4747 & Bryson* (MICH, TAES). **Washington Co.:** 4.5 mi W of Hollandale, above Black Bayou, S of hwy MS 12, 4 May 1986, *Bryson 4249* (ctb, SWSL); 0.5 mi N of Dunleith Plantation, 9 Jul 1986, *Bryson 4459 & Hasting* (ctb); 4 mi W of Hollandale, 22 Apr 1992, *Bryson 11340 & Newton* (BRIT/SMU, ctb, IBE, MICH, NLU, SWSL, TAES, USMH, VDB, VSC).

Carex molesta is known from Massachusetts and Vermont to Saskatchewan and southward to District of Columbia, Tennessee, Arkansas, Kansas, and Colorado (Mackenzie 1931; Steyermark 1963). These collections represent the first report of *C. molesta* from Mississippi. These collections are from the Delta and the Black Prairie regions in open areas on heavy, circumneutral to alkaline (calcareous) clay or marl soils that are periodically wet.

15. **Carex oklahomensis** Mack.

MISSISSIPPI. **Lee Co.:** E of Tupelo, 15 May 1992, *Bryson 11578* (ctb, IBE, MICH, MISS, MMNS, NLU, SWSL, TAES, USMH, VDB, VSC)

Carex oklahomensis is known from southwestern Missouri and Arkansas and southward to Oklahoma and Texas (Mackenzie 1931; Steyermark 1963). This collection represents the first report of *C. oklahomensis* for Mississippi and east of the Mississippi River. It is possible that *C. oklahomensis* was introduced into Mississippi in blown hay for erosion control along new highway construction at this site. This population was locally common along an open, wet roadside on a heavy clay soil.

16. **Carex oligocarpa** Schkuhr

MISSISSIPPI. **Tishomingo Co.:** ca. 1.2 mi S Mingo, 17 May 1992, *Bryson 11710 & Warren* (ctb, IBE, MICH, MMNS, SWSL, TAES, VDB, VSC).

Carex oligocarpa is reported from Vermont and Ontario to Iowa and southward to Alabama, Kentucky, and Texas (Mackenzie 1931). This collection is the first from Mississippi. A previous report of this taxon from Forrest County, Mississippi by Rogers (1977) was found to be *C. impressinervia* Bryson, Kral, and Manhart (Bryson et al. 1987; Bryson et al. 1991). *Carex oligocarpa* grew on a steep bluff

above a creek in a mesic *Acer-Carya-Fraxinus-Quercus* woods on a calcareous, sandy loam soil in the Tennessee River Hills Region.

17. **Carex ormostachya** Wieg.

VIRGINIA. **Augusta Co.:** Elliott Knob, on west slope up trail from Cold Spring to summit, 4 Jul 1937, *Allard 3186* (MICH), 8 Jun 1990, Naczi 2554 (ctb, FARM, MICH).

Carex ormostachya is known from Quebec to Minnesota and southward to Connecticut, Pennsylvania, and northern Michigan (Bryson 1980; Mackenzie 1931). Because Allard's specimen had lost most of its perigynia, additional material from the site was necessary to positively identify it. Exploration of the locality revealed *C. ormostachya* at approximately 1290 m (4200 ft) elevation on a lightly shaded, moist, rocky slope in a deciduous forest. It was rare and grew with *Acer pensylvanicum* L., *Carex trisperma* Dewey, and *Hamamelis virginiana* L. Apparently, these are the first collections of *C. ormostachya* from Virginia, since Mackenzie (1935), Bryson (1980), and Harvill et al. (1986) do not report it from the state. The Virginia population of *C. ormostachya* is in the Valley and Ridge Physiographic Province and disjunct approximately 240 km (150 mi) from the nearest previously known population in southern Pennsylvania [Bedford Co.: 5/8 mi SSE of Loysburg, 30 May 1961, *Berkheimer 20198* (PENN!)].

18. **Carex oxylepis** Torr. & Hook. var. **pubescens** Underwood

ALABAMA. **Madison Co.:** E of Huntsville, Monte Sano Mt., 2 May 1974, *Bryson 551* (ctb). MISSISSIPPI. **Oktibbeha Co.:** 1 mi N of Starkville, 25 Apr 1982, *Bryson 3218* (MICH).

Underwood (1945) described *C. oxylepis* var. *pubescens* from oak-hickory woods on bluffs along the Harpeth River near Pegram, Tennessee. Hermann (1954) reported *C. oxylepis* var. *pubescens* from Stone County, Arkansas. These are the first report of this variety from Alabama and Mississippi. These populations are unique because this variety and var. *oxylepis* occur together. In Alabama, *C. oxylepis* var. *pubescens* grew under a *Carya-Cotinus obovatus* Raf.-*Juniperus virginiana-Quercus-Ulmus* woods on a dark, heavy clay soil over limestone in the Cumberland Plateau section of the Appalachian Plateaus Physiographic Province. In Mississippi, it grew under a *Carya-Juniperus virginiana-Quercus-Ulmus* woods on silty loam to heavy clay soil in an area transitional from the Pontotoc Ridge to the Black Prairie regions. Additional research is needed to determine the taxonomic status of this variety, since the only trait distinguishing it from var. *oxylepis* seems to be the presence of pubescence on the perigynia.

19. **Carex picta** Steud.

MISSISSIPPI. **Monroe Co.:** 2.4 mi SSW of Greenwood Springs, 21 Apr 1986, *McDaniel 28582* (pistillate) & *28583* (staminate) (IBE, duplicates to be distributed). **Prentiss Co.:** 4 mi SE New Site, 11 Mar 1992, *Bryson 11199* (ctb, IBE, SWSL).

Carex picta is uncommon to rare from northeastern to southern Mississippi by

virtue of its habitat requirements (Bryson et al. 1991). Our records, both from the Tennessee River Hills Region, represent a new county (Prentiss) and a new population in Monroe County for Mississippi.

20. **Carex seorsa** Howe in Gord. & Howe

MISSISSIPPI. **Tishomingo Co.:** Tishomingo State Park, 23 Apr 1976, *Searcy 10* (MISS). **Walthall Co.:** N of Tylertown, 12 Apr 1991, *Bryson 10710* (ctb, IBE, MICH, MMNS).

These records represent the second and third stations for *C. seorsa* in Mississippi. The Walthall County population is about 420 km (265 mi) SSW of the nearest known station of *C. seorsa* in Prentiss County, Mississippi (Reznicek & Ball 1980; Bryson 1984) and represent the first report of *C. seorsa* from the Longleaf Pine Belt Region.

21. **Carex socialis** Mohlenbr. & Schwegm.

MISSISSIPPI. **Clay Co.:** 3.8 mi S of West Point, 7 May 1968, *McDaniel 10644* (IBE); 9.3 mi SE of West Point, 24 Apr 1971, *McDaniel 15012* (IBE). Coahoma Co.: ca. 3.5 mi SE of Dublin, 15 May 1990, *Bryson 9853 & S.&G. Jones* (ctb, IBE, MICH, VDB); 2.5 mi NW of Lula, 24 Apr 1992, *Bryson 11380 & Newton* (BRIT/SMU, ctb, IBE, MICH, NLU, SWSL, TAES, VDB, VSC). **Jasper Co.:** 5 mi NW of Montrose, 28 Apr 1989, *Carraway 687* (ctb, IBE). **Noxubee Co.:** Bluff Lake, 25 Apr 1963, *McDaniel 3525* (IBE). Pontotoc Co.: 0.7 mi S Pontocola, 18 May 1992, *Bryson 11737* (ctb, MICH). Scott Co.: Bald Hill, 10 May 1991, *Bryson 10810 & Weiland* (ctb). **Tunica Co.:** ca. 4 mi SE of Tunica, 24 Apr 1992, *Bryson 11399 & Newton* (BRIT/SMU, ctb, IBE, MICH, NLU, SWSL, TAES, USMH, VDB, VSC).

Our specimens represent new county records from the previously known Mississippi populations of this frequently overlooked sedge (Carter, Morris, & Bryson 1990; Naczi & Bryson 1990). All of these collections are from bottomland, hardwood forests on heavy clay or marl soils in the Jackson Prairie, Black Prairie and Delta regions.

22. **Carex stricta** Lam.

MISSISSIPPI. **Lafayette Co.:** 4.2 mi S of Oxford, 9 Apr 1987, *Bryson 5324* (ctb). **Monroe Co.:** W of Greenwood Springs, 21 Apr 1986, *McDaniel 28589* (IBE, duplicates to be distributed).

Carex stricta is known from Maine and Nova Scotia westward to Minnesota and southward to South Carolina, Mississippi, and Texas (Mackenzie 1931; Standley 1989). This taxon was first reported from northeastern Mississippi in the Central Hills and Tennessee River Hills regions (Bryson 1984), where it is found on sandy, acid soils near springs, seeps, bogs, and along small streams in mesic woods. Morris (1988) reported *C. stricta* from Grenada County, Mississippi. Our collections represent two new county records for Mississippi.

23. **Carex torta** Boott ex Tuckerm.

MISSISSIPPI. **Tishomingo Co.:** Tishomingo State Park, 31 Mar 1956, *Cooley 4671 & Ray* (MISSA); Yellow Creek Quad., Meat Hollow, 11 Apr 1979, *Rogers 46564* (MMNS).

Carex torta is known from Quebec and Nova Scotia to Minnesota and southward to Georgia, Tennessee, and Arkansas (Mackenzie 1931; Steyermark 1963). These collections represent the first reports of *C. torta* from Mississippi. It is rare in extreme northeastern Mississippi, apparently because its habitat of rocky stream beds is also rare within the state.

24. **Carex vestita** Willd.

ALABAMA. **DeKalb Co.:** ca. 4.5 mi S of Henagar, 8 May 1991, *Naczi 2891* (MICH).

Carex vestita was very rare at this site, a wet, sphagnous meadow on the Cumberland Plateau (Appalachian Plateaus Physiographic Province). The previously known geographic range of this sedge is southern Maine south to northern North Carolina and southern Tennessee (Fernald 1950; Radford et al. 1968; DeSelm 1990). The collection cited above is apparently the first from Alabama. It extends the known geographic range of the species southward from the nearest previously known population [Tennessee. Franklin Co.: SE of Tullahoma, 6 Jun 1962, *Ratledge & DeSelm 30640* (TENN!)] by about 90 km (60 mi).

25. **Carex willdenowii** Willd.

MARYLAND. **Cecil Co.:** 0.8 mi NNW of North East, 13 Jun 1990, *Naczi 2575* (DOV, MICH, PH).

At this site on the Fall Line of Maryland's Eastern Shore, *C. willdenowii* was rare in moist *Quercus-Pinus-Liquidambar styraciflua* forest that was being cleared. It grew in association with *C. glaucodea* Tuckerm., *C. swanii* (Fern.) Mack., and *Kalmia latifolia* L. Apparently, this is the first collection of *C. willdenowii* from eastern Maryland, although it occurs in the western part of the state (Tatnall 1946; Brown & Brown 1984).

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INTERNATIONAL CHECKLIST IN MACHINE READABLE FORM

The Biota of North America Program (BONAP) of the North Carolina Botanical Garden is pleased to announce the availability of the 1992 edition of *A Synonymized Checklist of the Vascular Flora of the United States, Canada, and Greenland* in machine-readable form. This work represents a comprehensive update of the 1980 hard-bound edition with a significant expansion of synonymy and accepted names.

Geographically, the work treats all accepted taxa and selected synonyms of the North American flora, north of Mexico, including the floras of the offshore islands of Puerto Rico and the U.S. Virgin Islands, Hawaii, St. Pierre, and Miquelon. Nearly 70,000 names are treated within the work. This work is available in two copyrighted versions: a) a synonymized checklist, similar in organization to the 1980 hard-bound publication and b) a thesaurus, which lists all names alphabetically with accepted names clearly indicated, and synonyms with their accepted name equivalents. Each work plays a different role in determining the disposition of names. Hard copy publication of both versions, through Timber Press, will not be available until early 1993.

Also available in electronic form is the common name for each fully accepted species found within the checklist area. These names have undergone extensive review by hundreds of individuals and are intended to assist editors, field biologists, naturalists, and others, who use common names in their work. The electronic version of all these files will be updated periodically. The update of each version will be dated and numbered for the purpose of scientific clarity.

All information will be available on an IBM compatible 3.5" diskette system in ASCII text format containing c. 25 megabytes of space. For details concerning licensing agreements, costs, etc., please contact Dr. John T. Kartesz at the following address:

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PEDIOMELUM OCKENDONII SP. NOV.: CORRECT NAME FOR *P. PALMERI* GRIMES (FABACEAE)

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INTRODUCTION

Rydberg (1919, p. 23), based on the name *Psoralea pentaphylla* L., proposed the combination *Pediomelum pentaphyllum* (L.) Rydb. and described it as a decumbent perennial species from Mexico. Ockendon (1965, p. 122), in his review of the taxonomy and nomenclature of this complex, ascertained that the type of *Psoralea pentaphylla* referred to a subacaulescent plant, whereas Rydberg's description, pertaining to elements possessing decumbent stems, represented a new species. It is evident from Ockendon's analysis that Rydberg inadvertently described a new species under a misapplied name. Ockendon named this new species as *Psoralea palmeri* Ock.

Psoralea palmeri, an invalid name

For *Psoralea palmeri*, Ockendon referred to Rydberg's description and remarked that his "reference to this previously validly published description obviates the Latin diagnosis, according to the present code of nomenclature." In checking the 1961 *Code* (Lanjouw et al. 1961), we found no Article addressing the publication of a new name for a taxon previously known under a misapplied name. However, Art. 36 stipulated that new taxa published after 1 Jan 1935 must be accompanied by a Latin description or diagnosis, or reference to one of these.

Unfortunately, Ockendon failed to realize that his proposal pertained to a nom. nov. for a misapplied name (i.e., a sp. nov.), and that a Latin diagnosis was essential for his *Psoralea palmeri*. In the present Code Art. 33. Note 1 (Greuter et al. 1988), it is explicitly indicated that the procedure for publication of a new name in place of a misapplied name is not the same as publishing a nomen novum for an illegitimate name; moreover, Art. 33 *Ex.* 9 indicated that for lack of "Latin diagnosis...," the trinomial *Juncus bufonius* var. *occidentalis* F.J. Herm., which was proposed in 1975 as a nom. et stat. nov. for *J. sphaerocarpus* auct. Amer., non Nees, was invalidly published.

We conclude that the above Article is applicable to Ockendon's treatment; therefore, to date, the name *Psoralea palmeri* Ock. remains invalid (see Art. 36.1). Grimes (1990, pp. 88-89) transferred *Psoralea palmeri* to *Pediomelum* and provided

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a description in English; hence, the combination *Pediomelum palmeri* Grimes is also invalid.

Pediomelum ockendonii (subgenus **Leucocraspedon** Grimes)

In place of *Psoralea palmeri* and *Pediomelum palmeri*, we propose *Pediomelum ockendonii* in honor of Ockendon. A Latin diagnosis is provided.

TAXONOMY

Pediomelum ockendonii Gandhi & Kartesz, sp. nov. TYPE: MEXICO. Tepehuanes, Durango, 4-25 Jun 1906, *Palmer 295* (NY). *Psoralea palmeri* Ock., Southw. Naturalist 10:122. 1965, nom. nud. *Pediomelum palmeri* Grimes, Mem. New York Bot. Gard. 61:88. 1990, nom. invalid.

A *Pediomelo rhombifolio* (Torr. & Gray) Rydb. differt in foliis pseudopalmatim 5-foliolatis habens; a *Pediomelo pentaphyllo* (L.) Rydb. differt in caulibus decumbentibus habens.

Differs from *Pediomelum rhombifolium* (Torr. & Gray) Rydb. in possessing mostly pseudopalmately 5-foliolate leaves, and also differs from *Pediomelum pentaphyllum* (L.) Rydb., in possessing decumbent stems.

Note: In Holmgren et al. (1985, p. 251), we found no type specimen listed for *Psoralea palmeri*. Citing a reference to Ockendon's article, a loan of the type specimen was requested from NY, but we were informed that the type was unavailable for a loan.

ACKNOWLEDGMENTS

We thank Paul A. Fryxell (TAES), Jimmy Massey and Rogers McVaugh (NCU) for helpful comments. Paul Fryxell provided the Latin diagnosis.

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THE STATUS OF *CRINUM STRICTUM* (AMARYLLIDACEAE)

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ABSTRACT

A literature review and statistical analyses of the traits used to distinguish *C. strictum* Herbert from *C. americanum* L. show that the species cannot be reliably separated. *Crinum strictum* is therefore considered to be conspecific with *C. americanum*.

In preparing a treatment of the genus *Crinum* for the Flora of North America Project, it became apparent that the plant referred to as *C. strictum* Herbert by Traub (1962), Correll & Johnston (1970), and Correll & Correll (1972) is not adequately distinguished from the more prevalent and widely distributed *C. americanum* L. Although Lehmiller (1987) asserts that *C. strictum* should be considered as synonymous with *C. americanum*, the retention of the name in Johnston (1990) and in Hatch et al. (1990) evidences that the matter has not been resolved. The object of this study is to reexamine, by statistical methods and literature review, the status of *C. strictum* in relation to *C. americanum*.

MATERIALS AND METHODS

The study is based upon examination of about 200 specimens borrowed from the following herbaria: ASTC, BAYLU, BRIT/SMU, FLAS, GA, GH, LAF, LL, LSU, MO, NCU, NLU, NO, NY, TAES, TEX, UNA, and USF. The lengths of the perianth tube and perianth segments, the character cited by Traub (1962) and Correll and Johnston (1970) as primarily distinguishing *C. americanum* from *C. strictum*, were measured. One hundred and twelve specimens of *C. americanum* had flowers suitable for measuring, while only three specimens of *C. strictum*, those cited by Moldenke (1962) and Traub (1962), were available for study. The limited number of data points for *C. strictum* permitted a two sample comparison of variances test (Zar 1984) be run to determine if statistical differences existed between the two populations for the traits measured. In addition, the same statistical test was used to compare the ratio of perianth tube to perianth segment length

A comprehensive literature review was also necessary because it became apparent that one had never been conducted for the species.

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RESULTS

From the beginning, *Crinum strictum* has been problematic. The plant has an interesting nomenclatural history, a review of which is essential for understanding the status of the plant, as proposed by Herbert, and as currently applied to some of the Texas expressions of *Crinum* .

Herbert's (1816) description of *C. strictum* included a brief Latin diagnosis and an excellent line drawing. The plant described has four flowers with tubes 5 unciali [or inches = 12.7 cm] long and perianth segments 3 – 1/4 unciali [8.3 cm] long. This relationship of tube to perianth segment length is also supported by the illustration, although "the figure of the plant is diminished." The description was based on a specimen grown in Spafforth, England from a bulb reportedly collected in Ceylon (Sri Lanka). Herbert doubted that this was the correct source since the plant had no affinities with any known *Crinum* from that area. In fact, he "doubted if it was from the East or West," mentions that the plant appears to have affinity with *C. americanum*, and suggested that the bulb may have been from the New World. In 1837, Herbert surmised, largely based on supposed relationships with *C. americanum*, that the location from which the bulb came was Mexico.

Traub (1962) amplified Herbert's original species description, based upon a plant grown in La Jolla, California from a bulb collected in Jefferson County, Texas. In his description and discussion, he presents two major points important to the identity of *C. strictum*. The "tepaltube" is given as 8.4 cm long and the "tepalsegs" as 10.8 cm long. He also determines that the bulb Herbert obtained was from Texas, based upon Herbert's (1837) surmise that the plant was from Mexico, which in 1816 included Texas. He suggested that it could have been collected in the general area of the Gulf Coast (Jefferson County), where Mrs. Carl Shirley found the bulb that ultimately provided the basis of the description amplification. The evidence for matching the two plants (the Herbert plant and the Shirley plant) appears to be Herbert's (1816) comment "it is remarkable for the erectness of all of its parts," which Traub (1962) describes in the Shirley plant as a "proudly upright stance." In a brief introduction, Traub also comments on the rhizome with "without exception ... [it] went down: never laterally as rhizomes usually do." This was not included in his species amplification. The current usage of the name *C. strictum* by Correll and Johnston (1970), Correll and Correll (1972), and its retention as a valid species in Johnston (1990) and in Hatch et al. (1990) is clearly based upon Traub's (1962) amplification of the original Herbert (1816) description. Basically, the name *Crinum strictum* is used to refer to those Texas *Crinum* which are distinguished from the more abundant *C. americanum* by perianth segments that are longer than the perianth tube.

In 1972, Hannibal reported that *Crinum strictum* Herbert is an illegitimate name because *C. strictum* Hornemann has name priority. Hornemann published that name, along with a Latin description, in *Enumeratio Plantarum Horti botanici Hafniensis* 13. 1807 and again in *Hortus Hafniensis* 1:318. 1813. That name,

according to Hannibal, refers to a species from the Caribbean area which differs completely from the Herbert plant. Both Hornemann references are listed in *Index Kewensis* immediately following the Herbert entry, but as is standard in the original indices, the year of publication is not given. Hannibal, therefore, proposed the name *C. texanum* Hannibal to refer to those plants formerly known as *C. strictum* Herbert. He erroneously states the name is a *species nova* rather than a *nomen nova*, but evidently effected the nomenclatural change. Anne Fox Maule, of Copenhagen, in providing me with copies of the Hornemann references and advising me that the publication is valid, stated "we (C) have no material of this species as is often the case with more or less succulent species from early publications" (pers. comm.). The matter was further complicated by both the *Gray Herbarium Index* and *Index Kewensis* incorrectly citing Hannibal's (1972) publication as volume 3 (which is year 1962) of the Bulletin of the Louisiana Society for Horticultural Research rather than volume 13 of year 1972.

From the above, it can be concluded that those plants of Texas currently referred to as *Crinum strictum* are based on a plant grown from a bulb which, largely upon morphological similarity to *C. americanum* alone, Herbert (1816, 1837) believed to be from the New World (possibly Mexico) and Traub(1962) said may be from the Texas Gulf coast (Jefferson Co.), probably based on erectness of flowers. The actual location of the source of the bulb is unknown. The plant was originally described by Herbert (1816) as having a corolla tube (1.5 x) longer than the perianth, yet in Traub's (1962) amplification of the description, also from a specimen under cultivation, the tube length is shorter than the perianth segments. This trait is emphasized because it is the major characteristic used to distinguish *C. strictum* Herbert from *C. americanum* L. Thus, there is ample doubt as to whether *C. strictum* as applied in Texas is specifically distinct from *C. americanum*. It is also an illegitimate use of the name *C. strictum*. Indeed, if the plants now referred to as *C. strictum* Herbert are specifically distinct from *C. americanum*, the legitimate name is *C. texanum* Hannibal. The following lines of evidence supports that *C. strictum* (or *C. texanum*) should be merged into *C. americanum*. This is in agreement with Lehmiller (1987), who, based upon morphological data and extensive field observation, also concludes that *C. strictum* is not specifically distinct from *C. americanum*.

1. Three statistical comparisons (Table 1) of tube length, perianth segment length, and a ratio of perianth segment length divided by tube length showed that no significant differences existed between those plants identified as *C. strictum* by Moldenke (1962) and Traub (1962) and *C. americanum* from both Texas and the southeastern United States.

2. The condition of perianth segments being longer than the tube is present in other native *Crinum* from southeast U.S.; e.g., *Ouchley s.n.* (LAF) from Louisiana and *Lakela & Long 29927* (USF) from Florida. Other herbarium specimens showed that the length of flower parts in the native southeastern *Crinum* is ex-

TABLE 1. Two Sample Comparison of Variances (Zar 1984).

Species	$\overline{X}$(N)[a]	S.E.[a]	Range[a]	Variance[a]	F[a]
		TUBE LENGTH			
C. americanum	11.9732(112)	0.192060	6.0 – 15.5	4.13150	1.3320[b]
C. strictum	10.9667(3)	0.113680	8.4 – 11.5	5.50330	
		PERIANTH SEGMENT LENGTH			
C. americanum	8.03125(112)	0.113680	6.0 – 11.0	1.44740	3.2909[b]
C. strictum	8.8667(3)	1260070	6.5 – 10.8	4.76330	
		RATIO (PERIANTH SEGMENT LENGTH DIVIDED BY TUBE LENGTH)			
C. americanum	0.6785(112)	0.010886	0.45 – 1.15	0.01327	10.8741[b]
C. strictum	0.8600(3)	0.219317	0.57 – 1.29	0.14430	

[a]$\overline{X}$(N) = mean and sample size; SE = standard error; Range = lowest and highest data values; F value = variance of *C. strictum* divided by variance of *C. americanum*

[b]$F_{0.05}$ (2), 111, 2 = 39.5, therefore all populations are statistically equal at the 0.05 level for all traits.

ceedingly variable and unreliable for specific delimitation (see range, Table 1). In fact, specimens of *C. americanum*, such as *Thieret 16609* (LAF) had tube lengths varying from 1 – 9.5 cm while perianth segments were up to 8 cm long. *Brooks et al. 943* (LAF) has a similar condition in which the perianth tubes were 5 – 12 cm long while the perianth segments were about 8 cm long. Thus these two specimens have flowers of both types in the same inflorescence (with tube longer than and shorter than the perianth segments), further supports that these traits are not reliable for specific separation.

3. Specimens mentioned by Moldenke (1962) as being part of the *C. strictum* group, have perianth segments that are shorter than the tube thus technically cannot be identified as part of the species.

4. All known specimens determined to be *C. strictum* were cultivated and thus not subject to the normal environmental conditions. Minor vegetative or habit differences, such as upright stance, mentioned by Traub (1962) may be due to factors of cultivation, treatments, or age or size of bulbs.

5. *Crinum strictum*, as proposed by Herbert (1816) has no described differences that separate it from *C. americanum*. He (1816, 1837) additionally emphasizes its affinity with *C. americanum*. It may be concluded that Herbert proposed the species as new because it was not from the southeast United States and that it was different from the native *Crinum* of its stated origin, Sri Lanka, or, as believed later, Mexico.

The plant cited as *Crinum strictum* var. *traubii* Moldenke by Correll and Johnston (1970), Correll and Correll (1972), and Hatch et al. (1990) should correctly be called *C. americanum* var. *traubii* (Moldenke) Hannibal, the transfer being effected by Hannibal in Bull. La. Soc. Hort. Res. 13:308. 1972. The plant is known only from cultivated specimens grown from bulbs collected in Hardin Co. It differs from var. *americanum* by its more numerous flowers (6 – 7), longer foliage, and deeper green color.

In transferring variety *traubii* from *C. strictum* to *C. americanum*, Hannibal (1972) gives the name as follows:

Crinum americanum var. **traubii** (Holdenke) Hannibal ssp. comb. nov.

The actual name is listed as a variety, but the nature of the transfer indicates subspecies, thus being ambiguous on rank of the taxon. The use of variety in the name, as in the basionym, appears to be the rank of the taxon accepted by Hannibal, and his use of the subspecific rank in denoting the nature of the transfer may be due to unfamiliarity in applying the Code. The transfer thus seems to be valid. Note also that Moldenke, author of the basionym, is incorrectly spelled as "Holdenke," most likely a typographical error.

Lehmiller (1987) proposed that var. *traubii* should also be merged into *C. americanum* because the cited differences may be artifacts of cultivation. The specimens that I examined, *Hamilton P. Traub 515a + b* (MO) and *675a + b* (MO, HOLOTYPE of *C. strictum* var. *traubii*), do differ from var. *americanum* in the traits described. The name is also validly proposed, and until such time as it can be shown that the differences cited by Moldenke (1962) are solely artifacts of cultivation, the varietal distinctness should be maintained.

ACKNOWLEDGMENTS

I am grateful to the curators and staff of the herbaria who provided specimens that made this study possible. Sidney McDaniel of the Institute for Botanical Exploration, Mississippi State, Mississippi, advised me on certain aspects of application of the International Code of Botanical Nomenclature. Anne Fox Maule of Copenhagen provided important literature and comments on the validity of *Crinum strictum* Hornemann. Dick T. Stalling of Northwestern State University, Natchitoches, Louisiana recommended and assisted with the application of the statistical test used in the study.

Appreciation is expressed to Baylor University for a Summer Research Sabbatical that allowed time for completion of this research.

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DOCUMENTED CHROMOSOME NUMBERS 1992: 1. CHROMOSOME NUMBERS OF SOME ARKANSAS FLOWERING PLANTS

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ABSTRACT

During the teaching of the squash technique to two students, Smith and his students accumulated a list of chromosome numbers of Arkansas vascular plants. Eight new numbers are herein reported, with comments on certain of the numbers.

METHODS

The procedures used were standard, including fixation of buds in Carnoy's solution and staining in 1% propio-carmine for anther squashes and pretreatment of roots in colchicine or 8-hydroxyquinoline, hydrolysis in HCl, and staining in 1% propio-orcein for root-tip squashes.

RESULTS

Twenty chromosome counts were accumulated. Study of the standard references for reported chromosome numbers (Goldblatt & Johnson 1990 and indices to plant chromosome numbers cited therein) indicated that eight of the 20 counts were new. It seems worthwhile to report these counts, and they are listed in Table 1. Voucher specimens for these counts are on deposit at the UARK herbarium.

DISCUSSION

A few comments on some of the new counts follow:

Polymnia cossatotensis is a rare, recently described species (Pittman et al. 1989), endemic to the Ouachita Mountains of Arkansas. Its nearest relatives appear to be *P. canadensis* L. and *P. laevigata* Beadle, both of which are also $n = 15$.

Silphium radula was recognized as a species in Cronquist (1980) and in Gandhi & Thomas (1989). Smith treated it as a synonym of *S. asperrimum* in the second edition of his *Atlas* (Smith 1988) but now considers it a putative hybrid, *S. asteriscus* L. var. *scabrum* Nutt. [including *S. asperrimum* of auth., not Hook.] × *S. integrifolium* Michx.; it is common in Arkansas. Whereas most species in *Silphium* have been reported as $n = 7$, *S. asteriscus* var. *scabrum* (as *S. asperrimum*) has been reported as $n = 8$.

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Table 1. Chromosome numbers of some Arkansas flowering plants.

APOCYNACEAE

Amsonia ciliata Walt. var. *ciliolata* (A. DC.) Lemke & Ayers—$2n = 22$. Baxter Co.: limestone glade near jct. of Hwy 5 and 342, S of Mountain Home, *Hyatt 498.03*.

ASTERACEAE

Facelis retusa (Lam.) Sch.-Bip.—$2n = 28$. Crawford Co.: lawn weed, ca. 1 mi S of Rudy, *Smith 4001*.

Polymnia cossatotensis Pittman & Bates—$n = 15$. Montgomery Co.: ca. 2 mi SE of the Albert Pike Recreation Area in the Ouachita National Forest; S32, T4S, R27W, *Hyatt 3586.49*.

Prenanthes crepidinea Michx.—$n = 16$. Baxter Co.: 3.3 mi S of Midway on Hwy 178, right 3.8 mi on County Rd 9 to Bruce Creek; S6, T19N, R14W, Hyatt *2346.03*.

Silphium radula Nutt.—$n = 8$. Polk Co.: on Carter Creek W of Nunley on Hwy 8, *Golden 390a*.

Solidago ouachitensis C. & J. Taylor—$n = 9$. Montgomery Co.: ca. 2 mi SE of the Albert Pike Recreation Area in the Ouachita National Forest; S32, T4S, R27W, *Hyatt 3589.49*.

FABACEAE

Desmodium pauciflorum (Nutt.) DC.—$n = 11$. Baxter Co.: Sylamore District of the Ozark National Forest, ca. 1/4 mi S of Rand Road; SW 1/4 of NW 1/4 of S16, T16N, R13W, *Hyatt 3451.03*.

RANUNCULACEAE

Delphinium treleasei Bush—$n = 8$. Baxter Co.: rocky roadside glade, in Cranfield Recreation Area, E of Mountain Home, *Hyatt 688.03*.

Solidago ouachitensis is a rare, recently described species (Taylor & Taylor 1986) of the Ouachita Mountains of Arkansas and Oklahoma; its chromosome number is typical for the genus.

All remaining reports are numbers previously known in the respective genera.

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DOCUMENTED CHROMOSOME NUMBERS 1992: 2. MISCELLANEOUS U.S.A. AND MEXICAN SPECIES, MOSTLY ASTERACEAE

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ABSTRACT

Chromosome numbers of 26 species of flowering plants from the U.S.A. and Mexico are reported: 21 species of Asteraceae, representing 18 genera; and one species each of the families Acanthaceae (*Ruellia corzoi*), Cochlospermaceae (*Amoreuxia wrightii*), Lobeliaceae (*Lobelia cardinalis*), and Passifloraceae (*Passiflora tenuiloba*). The count for *Amoreuxia wrightii* ($2n = 12$) is a first report for the genus. Significant counts among the Asteraceae include *Chaetymenia peduncularis* ($2n = 18$) and *Wedelia mexicana* ($2n = 24$), the former being a first report for the genus.

The following meiotic chromosome counts (Table 1) are documented by specimens deposited at the University of Texas, Austin (TEX). Previously uncounted taxa are represented by an asterisk (*). A double asterisk (**) indicates a new number for the species.

METHODS

Chromosome counts were made from bud material collected in the field and fixed in a modified Carnoy's solution (4:3:1; chloroform, absolute ethanol, glacial acetic acid), using standard squash procedures. All counts were made by the junior author, most of these checked by the senior author.

DISCUSSION

Previous counts for the small family Cochlospermaceae have been reported only for the relatively large genus *Cochlospermum* in which eight species have been counted, six of these being diploids, triploids, tetraploids and hexaploids on a base of $x=12$ (Fedorov 1969; Gill et al. 1979; Krishnan 1977; Maglio 1984; Morawetz 1986). The seemingly triploid counts of $n=18$ pairs reported for two species strongly suggest that the ancestral base chromosome number for the family is $x=6$. Our count of *Amourexia wrightii* ($2n=12$, or $x=6$) also supports this hypothesis.

The present report of $n=9$ for *Solidago juliae* agrees with previous counts (Nesom 1989), although the collection represents a new county record for its geographic distribution. All previous counts of *S. altissima* (=*S. canadensis* var. *scabra* [Muhl.] Torr. & Gray) have been hexaploid ($n=27$); the tetraploid level

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TABLE 1. Chromosome numbers.

Family/Species	Voucher[1]	Chromosome number (2^n)
ACANTHACEAE		
**Ruellia corzoi* Tharp & Barkley	U.S.A. TEXAS: *T 16026*	34
ASTERACEAE		
Ageratum corymbosum Zucc.	MEX. JALISCO: *S 2663*	40
Alloispermum scabrum (Lag.) H. Rob. var. *scabrum*	MEX. JALISCO: *S 2653*	32
Brickellia grandiflora (Hook.) Nutt.	U.S.A. NEW MEX.: *T 16010*	18
Chaenactis douglasii Hook. & Arn.	U.S.A. COLORADO: *T 16000*	12
**Chaetymenia peduncularis* Hook. & Arn.	MEX. NAYARIT: *M 1054*	18
Dyssodia acerosa DC.	U.S.A. TEXAS: *T 16024*	24 & 1-2 frag.
Dyssodia pentachaeta (DC.) B.L. Rob.	U.S.A. TEXAS: *T 16023*	16
Gaillardia aristata Pursh	U.S.A. COLORADO: *T 15995*	68
**Gnaphalium chartaceum* Greenm.	MEX. GUERRERO: *M 1017*	28
Grindelia squarrosa (Pursh) Dunal. var. *serrulata* (Rydb.) Steyerm.	U.S.A. COLORADO: *T 15996*	12
Heterotheca fulcrata (Greene) Shinners	U.S.A. TEXAS: *MT 2*	18
Hydropectis aquatica (S. Wats.) Rydb.	MEX. DURANGO: *S 2790*	18
Jefea brevifolia (A. Gray) Strother	MEX. DURANGO: *M 1100*	28
Jefea pringlei (Greenm.) Strother	MEX. PUEBLA: *M 899*	28
**Psacalium amplifolium* (DC.) H. Rob. & Brett.	MEX. GUERRERO: *M 1023*	60
***Psilostrophe tagetinae* (Nutt.) Greene	U.S.A. NEW MEX.: *J 188A*	32, 64
Solidago juliae Nesom	U.S.A. TEXAS: *T 16012*	18
Solidago altissima L.	U.S.A. TEXAS: *N 7260, N 7263*	36
Solidago sempervirens L.	U.S.A. TEXAS: *N 7255*	36
Thelesperma simplicifolia A. Gray	U.S.A. TEXAS: *T s.n.*	20
Trichocoronis rivularis A. Gray	U.S.A. TEXAS: *T 15955*	60
**Wedelia mexicana* (Sch. Bip.) McVaugh	MEX. SINALOA: *M 1061*	24
COCHLOSPERMACEAE		
**Amoreuxia wrightii* A. Gray	U.S.A. TEXAS: *MT 1*	12
LOBELIACEAE		
Lobelia cardinalis L.	U.S.A. TEXAS: *T 16014*	14
PASSIFLORACEAE		
***Passiflora tenuiloba* Engelm.	U.S.A. TEXAS: *T 16016*	24

[1]Letters before collection numbers pertain to the following collectors: J (Alice Jack); M (Mark Mayfield); MT (Matt Turner); N (Guy Nesom); S (Jacqui Soule); T (B. Turner).

(n=18) first reported here, from two localities in the near-coastal region of Texas (*N 7260* Brazoria Co. and *N 7263* Washington Co.), suggests that perhaps these plants represent a distinct evolutionary unit. They have been referred to as *S. altissima* var. *pluricephala* M.C. Johnston (see Nesom 1989 for a summary and details regarding variation in *S. altissima* in Texas).

Chaetymenia peduncularis (n=9) when originally described was said to belong to the tribe Tageteae, or perhaps the tribe Helenieae, near *Burrielia*. Rydberg (1914),

following most earlier treatments, positioned *Chaetymenia* in the subtribe Jaumeinae of the Helenieae, where it was said to relate to *Jaumea*. Indeed, McVaugh (1984) positioned the species in the latter genus, but noted that "The tribal relationships of *Jaumea* are not fully understood." He further notes that *Chaetymenia peduncularis* "may sometimes be keyed out with the genera of tribe Tageteae, because of the minute translucent glands in the leaves." Strother (1977) however, excluded the genus from his concept of the Tageteae. Turner and Powell (1977) positioned *Chaetymenia* within their concept of the tribe Coreopsideae, as did Stuessy (1977). Robinson (1981) did not account for *Chaetymenia*, but presumably would position it in the subtribe Jaumeinae, near, if not within, *Jaumea*.

Because of the above controversy, the chromosome count of *Chaetymenia* might bear upon the phyletic position of the taxon. Genera on a base of $x=9$ are relatively rare in the various tribes and/or subtribes to which *Chaetymenia* has been assigned. Within the Tageteae, only the monotypic aquatic genus *Hydropectis* has a base of $x=9$ (Keil and Stuessy 1977). Within the Coreopsideae numbers on a base of $x=9$ are also rare, but occur in the genera *Coreopsis* and *Thelesperma*, although most workers would consider these to be derived numbers in the genera concerned. The subtribe Juameinae (sensu Robinson 1981), however, has a base number of $x=19$. Overall, the chromosome number of *Chaetymenia* suggests that the genus is a rather remote element in the Helenieae, perhaps basal to the subtribes Varillinae and Clappiinae of Robinson (1981), both with base numbers of $x=18$, presumably derived from an ancestral base number of $x=9$.

The chromosome counts of $n=16$ pairs and $n=32$ pairs for *Psilostrophe tagetina* (*J188*A,B) were obtained from two plants growing at the same location, one presumably diploid, the other tetraploid. Tetraploids in *Psilostrophe* have previously been reported only in *P. mexicana* R. Brown. Indeed, the count was largely responsible for the cognition of *P. mexicana* (Brown 1977). Turner et al. (1988) reduced the latter to varietal rank in the widespread highly variable *P. gnaphalodes*. A broader survey of chromosome numbers among taxa of *Psilostrophe* is almost certain to reveal additional tetraploids.

ACKNOWLEDGMENT

We are grateful to Guy Nesom for the identifications and comments upon the genus *Solidago*.

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DOCUMENTED CHROMOSOME NUMBERS 1992: 3. DOCUMENTATION AND NOTES ON THE DISTRIBUTION OF *MELICA MONTEZUMAE*[1]

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McVaugh (1949), Correll and Johnson (1970), and Gould (1975) reported the occurrence of *Melica montezumae* Piper in Pecos and Brewster counties, Texas. Warnock (1977) reported its occurrence at Lancaster Hill in Crockett County and in Jeff Davis County. The chromosome number for this species has not been reported. This paper reports the chromosome number and range extentsion for *M. montezumae*.

Chromosome counts were made from mitotic divisions in root tip cells. Root tips were collected mid morning from plants growing under glass and placed in iron-priopionocarmin overnight at 5° C. Ten cells from six different plants from Crockett County were counted and the chromosome number was found to be $2n=2x=18$ (Fig. 1).

Melica montezumae was found to occur in three counties where it had not been previously reported. Collection data are:

TEXAS. **Sutton Co.:** 2 km W of Sonora on IH-10, 4 Mar 1992, *Read 922* (BRIT/SMU); 2 km S of exit to Caverns of Sonora on RR1989, 5 Mar 1992, *Read 923* (BRIT/SMU). **Terrell Co.:** 16 km S of Sheffield on TX 349, 25 Apr 1991, *Read & Simpson s.n.* (BRIT/SMU). **Val Verde Co.:** 3 km S of Juno Ranch Road on RR189, 25 Apr 1991, *Read & Simpson s.n.* (BRIT/SMU).

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[1]Contribution No. TA30461 of the Texas Agricultural Experiment Station.

FIG. 1. Photomicrograph showing 18 chromosomes of *Melica montezumae*. Line is equal to 0.01 mm.

NOTES

QUERCUS POLYMORPHA (FAGACEAE) NEW TO TEXAS AND THE UNITED STATES—*Quercus polymorpha* Schlect. & Cham. is a white oak of rather wide distribution occurring from the Sabinas range near Sabinas Hidalgo on the edge of the Sierra Madre Oriental in the state of Nuevo Leon, then south and east to Tamaulipas, San Luis Potosi, Vera Cruz, Oaxaca and Chiapas. In Central America it is found in Guatemala (Muller 1942). This is the first report of *Q. polymorpha* in Texas and the U.S. and is a range extension of approximately 500 km from those groves near Sabinas Hidalgo to this one grove on the periphery of the Devils River in Val Verde County, Texas. The oaks are located on the Dolan Falls Ranch recently purchased by the Nature Conservancy of Texas and were brought to the attention of the senior author by John Karges of the Nature Conservancy. Among the thirty or so oaks seen, there were three with an average height of >8 m and a trunk diameter of >15 dm. They are growing in Devils River Limestone (limestone-dolomite) (Barnes 1977) at an altitude of about 270 m. The trees sit in a small ravine just off the Devils River and could be considered part of a Sycamore-Pecan-Scrub Oak association as outlined by Smith and Butterwick (1975). The small arroyo is surrounded on three sides by a Wrights' Three Awn-Guallijo Association. The entire area surrounding the oak grove is rich in rare and/or unexpected plants. On the Devils River State Natural area to the north and east Smith and Butterwick (1975), found *Hesperaloe funifera*, *Pinus remota*, *Euphorbia antisyphilitica*, and *Jatropha cathartica*. Just northwest of the oak grove they discovered a small stand of *Bauhinia lunarioides*. Texas Parks and Wildlife (1990) also list *Hesperaloe parviflora* var. *parviflora* as part of the flora.

Cornelius H. Muller kindly made the identification. Collection data are:

TEXAS. **Val Verde Co.:** Dolan Falls, 22 Apr 1992, *Simpson, Karges, Carpenter 924221* (BH, BRIT/SMU, C.H. MULL.).

—*Benny J. Simpson, Texas Agricultural Experiment Station, 17360 Coit Road, Dallas, TX 75252, U.S.A.; John P. Karges, Texas Nature Conservancy, P.O. Box 1465, Fort Stockton, TX 79735, U.S.A.; John M. Carpenter, P.O. Drawer 430, Fort Stockton, TX 79735, U.S.A.*

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SACCIOLEPIS INDICA (POACEAE) NEW TO LOUISIANA—*Sacciolepis indica* (L.) Chase (Poaceae) is native to India and was reported as introduced in a Government pecan orchard, Thomasville, Georgia by Hitchcock (1950). Godfrey and Wooten (1979) report it from Florida to North Carolina and Gould (1975) reports its occurrence in Texas. Recent collections form Louisiana are apparently the first for the state; it is not in Allen (1980).

The collections data are:

LOUISIANA. **Allen Parish:** infrequent in pine forest ca. 4 mi N of Oberlin just E of U.S. 165, 1 Oct 1981, *Allen 11747* (LAF, LSU, NLU). **Vernon Parish:** pine forest near tank wash pond off Artillery Rd on Ft. Polk ca. 0.5 mi E of North Fort Polk in Sec. 36 T2N R8W., 18 Oct 1992, *Allen and Slaughter 17292* (NLU).

—Charles M. Allen, Dept. of Biology, Northeast Louisiana University, Monroe, LA 71209, U.S.A.

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CAREX OUACHITANA (CYPERACEAE) NEW TO TENNESSEE—*Carex ouachitana* Kral, Manhart, & Bryson was described from the arenaceous oak-hickory-pine uplands of the Ouachita mountain complex in western Arkansas and eastern Oklahoma (Kral et al. 1987). Although this taxon is locally abundant and morphologically distinct from its closest relatives *C. hitchcockiana* Dewey and *C. oligocarpa* Willd., the ecology and phytogeography of *C. ouachitana* and the related disjunct species *C. asynchrona* Naczi (Naczi 1989) and *C. impressinerva* Bryson, Kral and Manhart (Bryson et al. 1987, Naczi and Bryson 1990) are only now becoming better known (C.T. Bryson pers. comm. 1991). When described, collections of *C. ouachitana* were cited from Howard and Polk counties, Arkansas and LeFlore County, Oklahoma (Kral et al. 1987). Additional stations were reported from the western Ouachita Mountain complex in Montgomery and Sebastian counties, Arkansas (Orzell and Bridges 1987) and from the eastern Ouachita Mountain complex in Garland and Perry counties, Arkansas and from Boston Mountains in Madison and Washington counties, Arkansas and Cherokee County, Oklahoma (Naczi and Bryson 1990).

During routine field surveys, the author discovered a large, strongly scaly-rhizomatious *Carex*. The perigynia with many impressed nerves clearly place the

plant in the section *Oligocarpae*. The author suspected that the plant was *C. ouachitana* and sent a specimen to Charles T. Bryson, who confirmed this identification. The report herein is the first report of *C. ouachitana* from east of the Mississippi River and outside the Boston and Ouachita mountains. This new station extends the range eastward by 550 miles. *Carex ouachitana* is reported from the following collection:

TENNESSEE. **Clay Co.:** Arcott Road, 2.5 mi N of Arcott Church, 29 Apr 1991, *V.B. McNeilus s.n* (Charles T. Bryson pers herb., TENN, VDB).

At this locality, *C. ouachitana* was discovered on rocky soil in open to partially shaded areas adjacent to a paved county road. Four colonies were located 40 to 200 yards apart with an estimated 1500 culms and pseudoculms. The size of this population suggests that *C. ouachitana* may be native to Tennessee. Associates with *C. ouachitana* include *Asclepias tuberosa* L., *Carex albursina* Sheldon, *C. careyana* Dewey, *C. cephalophora* Willd., *C. jamesii* Schw., *Carya* sp., *Juniperus virginiana* L., *Lithosperum canescens* (Michx.) Lehmann, *Lonicera sempervirens* L., *Matelea carolinesis* (Jasq.) Woodson, *Nothoscordum bivalve* (L.) Britt., Desf., *Solanum carolinense* L., *Scleria oligantha* Michx., *Smilacina racemosa* (L.) Desf., *Tephrosia virginiana* (L.) Pers., *Ulmus alata* Michx., and *Verbena simplex* Lehmann.

I thank Charles T. Bryson, USDA, ARS Southern Weed Science Laboratory, Stoneville, MS for reviewing the manuscript and providing helpful comments.
—*Vernon B. McNeilus, Herbarium, Department of Botany, University of Tennessee, Knoxville, TN 37996-1100, U.S.A.*

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RANGE EXTENSION FOR *ARALIA RACEMOSA* (ARALIACEAE) IN MISSISSIPPI—*Aralia racemosa* L., spikenard, is known from mesic woods and ranges from Quebéc, Nova Scotia, New Brunswick, southward to Georgia and Mississippi and west to Kansas, Missouri, and North Dakota (Fernald 1950, Radford et al. 1968, Small 1933). In Mississippi, it has been reported in

woodlands on limey soils in the northeastern part of the state from East Port (Tishomingo Co.), Itawamba Co., the Hatchie Hills (Prentiss Co.), Ripley (Tippah Co.), and Columbus (Lowndes Co.) (Lowe 1921). Additional stations were reported from Tippah County near Ripley and Walnut (Meeks 1984). All of these collections are from the Tennessee River Hills and Pontotoc Ridge topographic regions as described by Lowe (1921). On September 20, 1984, the junior author observed a small population of *A. racemosa* in Tallahatchie County, Mississippi. Several visits to the site by both authors together or alone were unproductive in relocating this species. In the fall of 1990, the senior author located a single plant of *A. racemosa* at this site. It was growing on a sandy loam soil above a small, sandy and gravely stream bottom in a loessal ravine that empties into the Yazoo-Mississippi Alluvial Plain north of Charleston, Mississippi. This station is about 150 km W or SW from the nearest previously known populations in Mississippi and is the first from the Loess Bluff Region. Because this site and those reported by Meeks (1984) are the only extant populations of *A. racemosa* known in Mississippi, it was recently added to the Mississippi Natural Heritage Program Special Plant List (14 Feb 1992).

Collection data for *A. racemosa* at this new location are as follows:

MISSISSIPPI. **Tallahatchie Co.:** 7.2 mi N jct hwys MS 32 & 35 to E of hwy MS 32; N of Charleston, 14 Sep 1990, *Bryson 10410 & Newton* (FLAS, GA, IBE, MICH, MMNS-MISSISSIPPI MUS. NAT. SCI., MO, NLU, SWSL, TAES, VDB).

Associates of *A. racemosa* in the mesic ravine include *Actaea pachypoda* Ell., *Adiantum pedatum* L., *Arisaema dracontium* (L.) Schott, *A. triphyllum* (L.) Schott, *Carex abscondita* Mack., *C. artitecta* Mack., *C. blanda* Dewey, *C. laxiflora* Lam. var. *serrulata* Hermann, *C. oxylepis* Torr. & Hook., *C. retroflexa* Willd., *C. rosea* Willd., *C. willdenowii* Willd., *Cynoglossum virginianum* L., *Euonymus americanus* L., *Fagus grandifolia* Ehrhart, *Liriodendron tulipifera* L., *Lithospermum tuberosum* Rugel ex DC., *Magnolia acuminata* L., *Osmorhiza longistylis* (Torr.) DC., *Pachysandra procumbens* Michx., *Phlox divaricata* L., *Quercus rubra* L., *Ranunculus recurvatus* Poiret, *Sanicula gregaria* Bicknell, *Smilacina racemosa* (L.) Desf., *Trillium recurvatum* Beck., and *Uvularia grandiflora* Smith.

We thank Richard Carter (VSC), Sidney McDaniel (IBE), and Ken Gordon (MMNS) for helpful comments and reviewing the manuscript.—*Charles T. Bryson, USDA, ARS, Southern Weed Science Laboratory (SWSL), Stoneville, MS 38776, U.S.A. and Michael Wayne Morris, Department of Botany, University of Florida, Gainesville, FL 32611 U.S.A.*

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SCIRPUS FLUVIATILIS (CYPERACEAE) IN TENNESSEE AND SOUTHEASTERN UNITED STATES—*Scirpus fluviatilis* (Torrey) Gray (river bulrush) is a rhizomatous species that characteristically grows in dense, pure, and often totally vegetative stands. Leafy culms are sharply trigonous, stout, and up to 2 m in height. The inflorescence is a compound umbel and achenes are obovoid, triangular, 4 – 5 mm long, and with six persistent bristles. However, flowers and achenes are not regularly produced. Typical habitats include margins of freshwater (usually calcareous) lakes, large streams, sloughs, swamps, marshes, and oxbow lakes. The distribution is from New Brunswick to Saskatchewan and Washington, New England south to Pennsylvania and Virginia, westward to Ohio, Indiana, Illinois, Kentucky, Missouri, Kansas, and in California and New Mexico (Fernald 1950, Schuyler 1967, Steyermark 1963).

Two historical accounts credit this species to Tennessee. Gattinger (1901), in his Tennessee Flora, reported river bulrush from "Bogs along Ocoee River, E. Tenn." Underwood (1932), in a catalogue of the state's Cyperaceae, included the species with the annotation "In Tennessee, A. Gattinger in bogs along Ocoee River, Palk [*sic*, Polk] County, East Tennessee."

There is apparently no documentation for these reports. If Gattinger collected a voucher, it was lost when fire destroyed the University of Tennessee Herbarium in 1934. It appears that Underwood based his report solely on the Gattinger account; the addition of Polk County is not significant since the Ocoee River flows only through that county in Tennessee. Later, Underwood did not include *S. fluviatilis* in the list of Tennessee monocots which he co-authored (Sharp et al. 1956).

It is unlikely that river bulrush occurs in East Tennessee today. If the Gattinger report is authentic, impoundments and sedimentation have altered the Ocoee River shoreline to such an extent that the species probably has been extirpated. Numerous studies there and along the nearby Hiwassee River by one of us (BEW) have not discovered river bulrush, and it is not listed in other accounts of the Tennessee wetland flora (Isely 1946, Robinson and Shanks 1959, Guthrie 1989, Webb and Bates 1989, Henson 1990).

River bulrush was not listed by Tucker (1987) in his treatment of Cyperaceae

for the Generic Flora of the Southeast, a long-term project of Harvard University that includes Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, and Tennessee. Other major references addressing all or part of this geographic area also do not include *S. fluviatilis* (Small 1933, Eyles and Robertson 1944, Radford et al. 1964, Godfrey and Wooten 1979).

The distribution is sparse in contiguous states to the northeast, north, and west of Tennessee. It is known from three counties in Virginia (Harvill et al. 1986) where it is of special concern (Porter and Wieboldt 1991), and from two counties in Kentucky (Arnold and Beal 1981, Beal and Thieret 1986), where it is threatened (Endangered Species Committee of Kentucky, 1986). Smith (1988) does not report it from Arkansas, but notes possible occurrence in the northeastern part of that state because of nearby records from Missouri. Steyermark (1963) maps it mostly from northern and central Missouri counties with scattered occurrences southeastward.

A large stand of sterile plants tentatively identified as *Scirpus fluviatilis* was observed in Henry County, western Tennessee, throughout the 1988, 1989, and 1990 growing seasons. Efforts to induce flowering were carried out in late winter 1991, when rhizomes were transferred into aquatic environments both in and out of a heated greenhouse at the University of Tennessee, Knoxville. Other rhizomes were "planted" in habitats near and similar to those of the colony. None of these efforts was successful (plants grew but did not flower), but on a visit to the Henry County site on 22 May and 21 June 1991, we found a few flowering-fruiting plants from which vouchers were collected and positive identification made.

We now have located several colonies, one consisting of hundreds of plants, over a shoreline distance of about three miles along the west shore of Big Sandy River, six miles southwest of its confluence with the impounded lower Tennessee River (Kentucky Reservoir). Colonies are in open, sandy alluvium and mostly in shallow water except during seasonal reservoir drawdowns. Although well established and protected within a U.S. Wildlife Management Refuge, river bulrush should be considered an element of concern in Tennessee.

Citations for our vouchers confirming *Scirpus fluviatilis* as part of the Tennessee and the southeastern U.S. flora are:

TENNESSEE. **Henry Co.**: Big Sandy Unit of the Tennessee National Wildlife Refuge, 22 May 1991, *Chester & Wofford 91-10* (APSC, TENN); same site, 21 Jun 1991, *Chester 91-29* (APSC, TENN, VDB).

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EUSTACHYS CARIBAEA (POACEAE: CHLORIDEAE) IN TEXAS—*Eustachys caribaea* (Sprengel) Herter, native to South America, is found in Argentina, Brasil, Paraguay, and Uruguay (Renvoize 1984). The first United States report was in Louisiana by McKenzie et al. (1987). Specimens of *E. caribaea* from Texas were first determined from material that had been misidentified as *E. retusa* at **TAES**. All Texas specimens of *Eustachys* were then examined from the following herbaria: BRIT/SMU, LL, MO, TEX, and US to find additional specimens of *E. caribaea* and to determine the status of other *Eustachys* in Texas.

Prior to this report of *E. caribaea*, only two species of *Eustachys* were reported to occur in Texas: *E. petraea* (Swartz) Desvaux and *E. retusa* (Lagasca) Kunth (Anderson 1975, Gould 1975, and Hatch et al. 1990). *Eustachys distichophylla* (Lagasca) Nees has been listed as occurring in Texas (Cory and Parks 1937, Chase 1951, and McKenzie et al. 1987). Chase (1951) reported examining a specimen of *E. distichophylla* from Bastrop County, Texas. Upon examining herbarium specimens, three specimens were found identified as *E. distichophylla* from Bastrop Co.; *Duval 385* (**TEX**), *Boy s.n.* (**TEX**), and *Plonk 40* (US), which could have been examined by Chase. These specimens are *E. retusa* and not *E. distichophylla*. All Texas specimens identified as *E. distichophylla*, except for some that had been cultivated in experimental plots and nurseries, are *E. retusa*. Anderson (1975) reports that these two species can be readily confused. The two species can be distinguished by the following characters: *E. distichophylla* has a fertile (lowermost) floret 2.4 mm or longer, the sterile (uppermost) floret is oblanceolate, and the apex is obtuse to acute; whereas *E. retusa* has a fertile (lowermost) floret less than 2.4 mm long and the sterile (uppermost) floret is cuneate with a truncate apex. Since no specimen of *E. distichophylla* was found from Texas it was omitted from the key.

Superficially *E. caribaea* resembles *E. petraea* (when immature), and vegetatively all three species are similar. The following is a key to identify the species of *Eustachys* found in Texas. The species can be best differentiated by using mature specimens.

KEY TO *EUSTACHYS* OF TEXAS

1. Midvein (keel) of lowermost (fertile) lemma glabrous ..... *E. retusa*
1. Midvein (keel) of lowermost (fertile) lemma pubescent 2
   2. Spikelets dark brown to black (light brown only when very immature); lowermost lemma margins glabrous on the lower 1/2 to 2/3, the upper part of the lemma margins with short usually appressed trichomes 0.1 – 0.4 mm long; uppermost (sterile) lemma 0.8 – 1.0(1.2) mm long ..... *E. petraea*
   2. Spikelets pale to golden brown; lowermost lemma margins pubescent the entire length, trichomes on the lemma margins appressed to spreading, more than 0.5 mm long; uppermost (sterile) lemma 1.3 – 1.5 mm long ..... *E. caribaea*

Eustachys caribaea has been referred to as *Chloris bahiensis* Steudel (Cabrera 1970, Rosengurtt et al. 1970), *C. capensis* (Houtt.) Thellung (Chase 1951, Burkart 1969) and *C. capensis* var. *bahiensis* (Steudel) L.R. Parodi (Burkart 1969). For a more indepth discussion on the nomenclature of this species see McKenzie et al. (1987).

DISTRIBUTION OF *EUSTACHYS CARIBAEA* IN TEXAS

Specimens examined. TEXAS. **Brazos Co.:** in the SW corner of the intersection of FR 2818 and FR 60 (W of College Station) on and around the Department of Rangeland Ecology and Management (Texas A&M University) barn and greenhouse compound; open pasture, 6 Nov 1970, *Cooper 46* (TAES); 28 Sep 1972, *Clark 762* (TAES); 16 Oct 1987, *Thompson 24* (TAES); 1 Oct 1990, *Wipff 1800, Hatch & Jones* (MO, PAUH, SMU, TAES, TEX, US, UTEP). **Caldwell Co.:** Corner Store, Luling, Gonzales Rd., sandy land, 18 Jul 1936, *Silveus 1440* (TEX). **Gonzales Co.:** Albert Barnes Ranch at Cheapside, Sep 1987, *Wright s.n.* (TAES). **Guadalupe Co.:** 6.7 mi S of Seguin, sandy roadside, 9 Apr 1955, *Shinners 19511* (SMU); Seguin, 14 Aug 1940, *Kellogg s.n.* (TEX). **Jackson Co.:** between Edna and Victoria, 21 Aug 1941, *B.C. Tharp 7210 & Silveus* (TEX).

—J.K. Wipff and Stephan L. Hatch, S.M. Tracy Herbarium, Department of Rangeland Ecology and Management, Texas A&M University, College Station, TX 77843-2126, U.S.A.

ACKNOWLEDGMENTS

We would like to thank LL, MO, SMU, TEX, and US for loaning specimens. We would also like to thank Kelly W. Allred (NMCR) and Stanley D. Jones (TAES) for their reviews and suggestions on this manuscript. This is Technical Bulletin TA 30121, Texas Agricultural Experiment Station.

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ISOETES ENGELMANII (ISOETACEAE) AND *JUNCUS TRIGONOCARPUS* (JUNCACEAE) NEW TO ARKANSAS—A recent paper (Thomas et al. 1991) reported 32 taxa new to Arkansas. We herein report two additional species which can be considered as an addendum to this paper.

Smith (1988) lists two species of *Isoetes* in Arkansas: *I. butleri* Engelm. and *I. melanopoda* Gay & Dur. Both species possess tuberculate-walled megaspores. The reticulate-walled *I. engelmanii* A. Br. was recently discovered by Don Culwell in Cleburne County in north central Arkansas and the location reported to Eric Sundell and R. Dale Thomas.

Specimen collected: ARKANSAS. **Cleburne Co.:** alluvial soil, sand bars, and pools along Little Red River at the end of Ark. 210 at Cow Shoals E of Heber Springs and Ark. 110, 21 Oct 1990, *Thomas, Sundell, & Amason 122,070* (NLU, SBSC).

Juncus trigonocarpus Steud. is an acid bog species ranging in the coastal plain from North Carolina S and W to E-central Texas. It was recently found by Carl Amason in Union County in south central Arkansas.

Specimen collected: ARKANSAS. **Union Co.:** very wet boggy area on electrical transmission high-line right-of-way NW of Hwy 167 and NE of Ark. 335, ca. 2.3 mi S of Calion, 4 Aug 1989, *Thomas & Amason 111,678* (NLU, SBSC).

Among the rush species now reported for Arkansas only *J. trigonocarpus* Steud., *J. subcaudatus* (Engelm.) Cov. & Blake, and *J. canadensis* Gay ex Laharpe have seeds with tail-like membranous appendages. These appendages are as long or longer then the seed body in *J. canadensis* and *J. trigonocarpus,* while in *J. subcaudatus* the appendages are much shorter than the seed body. The mature capsule of *J. trigonocarpus* is much longer than the perianth and in *J. canadensis* the capsule and perianth are about equal in length or the capsule is slightly longer then the perianth.

—Larry E. Brown, Houston Community College, 1300 Holman Street, Houston, Texas 77270-7849 U.S.A. and R. Dale Thomas, Herbarium, Department of Biology, Northeast Louisiana University, Monroe, LA 71209, U.S.A.

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FIRST DOCUMENTATION OF *MIKANIA CORDIFOLIA* (COMPOSITAE) IN TEXAS—This constitutes the first report of *Mikania cordifolia* (L.f.) Willd. in Texas. The species is apparently the most widely distributed member of the genus in the New World, being known from northern Argentina throughout the wet American tropics to the southeastern United States. Within the U.S., its distribution is somewhat disjunct, occurring in peninsular Florida, southern Mississippi, and Louisiana. The species was treated as part of the Texas flora in the *Botany of West Texas* by Coulter (1892). Since a voucher specimen has never been located, it is likely that its inclusion was based upon its probable occurrence in Texas, since it was known from Louisiana and Mexico. The species is not included in Johnston's (1990) list updating the *Manual of the Vascular Plants of Texas* (Correll & Johnston 1970). It is included in *Checklist of the Vascular Plants of Texas* by Hatch, Gandhi and Brown (1990) with the notation that it is *expected to occur* in the Pineywoods of east Texas.

The specimens cited below were discovered by the senior author, a student of *Mikania* since 1972, during visits to various herbaria in connection with writing treatments of various genera for the Flora of North America Project. The *Gough s.n.* specimen cited below was correctly determined, but not reported. The *Amerson 689 & Watson* specimen was incorrectly determined as the prevalent *Mikania scandens* (L.) Willd. It is probable that the species is more abundant in east Texas (and possibly may occur in both south Alabama and Georgia) but is often misidentified as *M. scandens*. The two species may be separated by using the following key:

1. Heads 7 – 10 mm long; phyllaries 6 – 8 mm long; corolla teeth linear, slightly longer that the length of the throat, crisped-reflexed when dried; achenes 3 – 4 mm long; stems prominently hexagonal; leaves ovate to deltate; plant gray tomentulose to tomentose ..... *Mikania cordifolia*
1. Heads 5 – 6 (7) mm long; phyllaries 3 – 6 mm long; corolla teeth deltate, about one-half the length of the throat, flat in the dried state; achenes 1.8 – 2.2 mm long; stems terete to obscurely hexagonal; leaves triangular to triangular-ovate; plant glabrate to densely pilose ..... *Mikania scandens*

Additional information is presented in Cronquist (1980), Gandhi & Thomas (1989), and Holmes (1981).

Voucher specimens: TEXAS. **Newton Co.**: near cattle gap on Texas 642, 1/4 mi S of Toledo Bend Dam, 1 Apr 1980, *Robert C. Gough s.n* (NLU); in low moist area near Sabine River, on way to Deweyville, 2 Sep 1971, *Peggy A. Amerson 689 & Geraldine Watson* (BRIT/SMU).

—*Walter C. Holmes, Dept. of Biology, Baylor University, Waco, TX 76798-7388, U.S.A.; R. Dale Thomas, Herbarium, Dept. of Biology, Northeast Louisiana University, Monroe, LA 71209, U.S.A.; and Barney L. Lipscomb, Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060, U.S.A.*

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THE 1992 DELZIE DEMAREE TRAVEL AWARD

An endowment to underwrite an annual travel award ($250) in memory of Dr. Delzie Demaree is given annually to a graduate student in systematics for travel to the Systematics Symposium sponsored each fall by the Missouri Botanical Garden in St. Louis. Such an award is a very appropriate way to honor Dr. Demaree and to continue his legacy of assistance to students of botany.

Elena Conti, a graduate student of Kenneth J. Sytsma at the University of Wisconsin-Madison, is the 1992 recipient of the fourth annual Delzie Demaree Travel Award. Her dissertation is focused on the elucidation of phylogenetic relationships within the family Onagraceae and among families within the order Myrtales using *rbc*L sequence data.

IN MEMORIAM

EMANUEL D. RUDOLPH
(1927 – 1992)

The Board of Trustees of The Ohio State University expresses its sorrow upon the death June 22, 1992, of Emanuel D. Rudolph, Professor Emeritus of the Department of Plant Biology.

Professor Rudolph was born September 9, 1927, New York, New York. He received his B.A. from New York University in 1950 and his Ph.D. from Washington University (St. Louis) in 1955.

Dr. Rudolph taught in the Department of Botany (now Plant Biology) from 1961 – 89; was chairperson of that department from 1978 – 87; he took early retirement in 1989 and continued to teach one course a year. He served as Director of the Institute of Polar Studies (now Byrd Polar Research Center) from 1969 – 73, and Director of the Environmental Biology Graduate Program, 1972 – 78. And he was curator in the Ohio State University Herbarium.

Dr. Rudolph did research on lichens and the history of botany, authored numerous scientific papers on those topics, edited a book on symbiosis and parasitism, wrote more than 150 book reviews in major journals, and presented more than 100 papers at scientific meetings. He was active in professional societies and other organizations; he was a Fellow of the American Association for the Advancement of Science, a Fellow of the Ohio Academy of Science, a Fellow of the Arctic Institute of North America and a Fellow of the Linnean Society of London. Dr. Rudolph was the recipient of several awards and honors, among them; the Antarctic Medal of the United States, in 1979. "Rudolph Glacier" in Victoria Land, Antarctica was named after him by the U.S. Board of Geographical Names, and *Edrudia*, a genus of lichens, was named after him in 1980.

Dr. Rudolph was President-Elect of the Ohio Academy of Science; President-Elect of the Friends of the Library (Ohio State University), a group of which he was a founding member and ardent supporter; and Past President of the Friends of the Byrd Polar Research Center.

Dr. Rudolph was a respected researcher, valued teacher and mentor, and generous friend to people in many areas, at Ohio State and around the country. His enthusiasm for learning and scholarship, his gentle good humor and cooperative spirit, were a positive example to all who knew him.—*Ronald L. Stuckey and Barney L. Lipscomb.*

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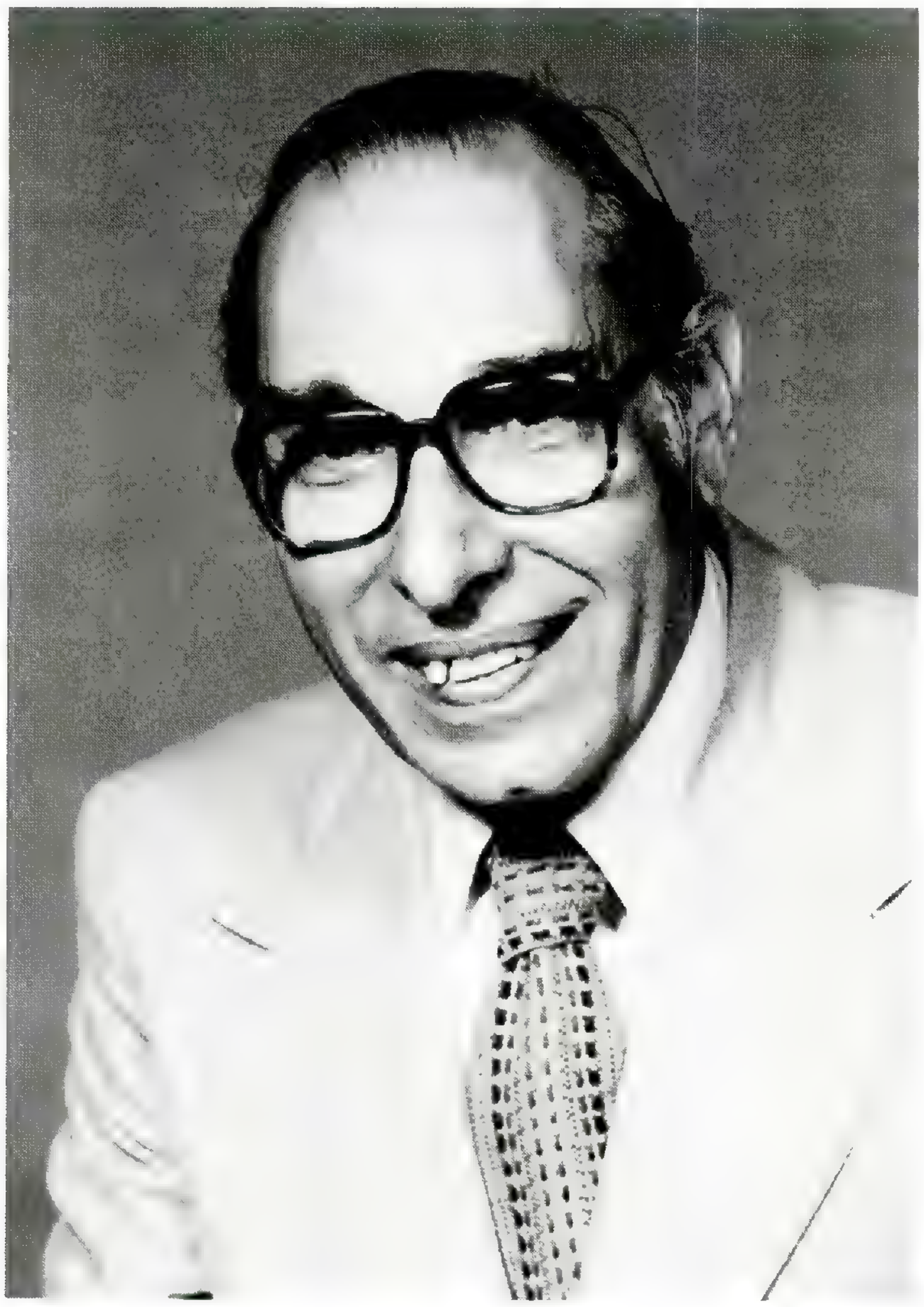

EMANUEL D. RUDOLPH
(1927 – 1992)

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BOOK REVIEW

CASSIN, JOHN. 1991. **Illustrations of the Birds of California, Texas, Oregon, British and Russian America.** Facsimile of 1856 Edition. Texas State Historical Association, Austin. Hardbound $26.95 Introduction 42 pp + 298 pp.

A book in hand is worth fifty birds in the bush! As a naturalist you will not want to miss *Illustrations of the Birds*, a beautiful facsimile of the 1856 classic by John Cassin, "sometime the Nestor of America ornithology" (Coues). Yes, it is an overlooked botanical book. The fifty color plates often include plants as backgrounds featured in what Cassin designed as a supplement to Audubon's *Birds of America* with its plant backgrounds. This is a book for the historically prying reader. Published originally in the tracks of Pacific Railroad Surveys that crossed Texas and Mexican Boundary Survey, naturalists of the United States Army Corp., and other Smithsonian collectors encouraged by Baird—all fill the thickety text. Col. George A. McColl wrote,

> On one occasion when approaching Limpia Creek (W. Texas), with a small party, on my way to El Paso, I discovered a fine male *Paisano* in the open road, about one hundred yards in advance. For amusement, I put spurs on my horse and dashed after him, followed by one of my men. For full four hundred yards, I ran him along a road level and smooth as a floor; and over which, with straightened neck and slightly expanded wings, he swiftly glided, seeming scarcely to touch the ground.

You will name the bird! There are ten other quotations from McColl's journal.

John Cassin, born 6 September 1813, in Media, outside Philadelphia, was a pupil in Westown, the Quaker boarding school, a nursery of naturalists—Thomas Say, J.K. Townsend, and E.D. Cope were there. Cassin became manager of a leading engraving firm and a city council member, but from the age of nineteen he had examined 385 plants described in William Darlington's *Florula Cestrica*, natural history energized his life. Two brothers, a wealthy Philadelphia businessman, Edward, and Thomas B. Wilson, MD., cast Cassin's fate. In his informative, documented introduction, Robert M. Peck of the Academy writes, "Cassin, who dispensed bird names like military honors in his own publications, was himself so honored more than any other American ornithologist." The role of arsenic poisoning from handling hundreds of treated bird skins is a little-noted topic. Peck concludes that "Cassin's long exposure to arsenic poisoning from handling hundreds of treated bird skins is a little-noted topic. Peck concludes that "Cassin's long exposure to arsenic almost certainly played a part in his diminishing health" and his death at fifty-five.

It was Thomas B. Wilson's zeal for ornithology that brought to the Academy of Sciences in Philadelphia outstanding bird collections which would put the Academy in first place among museums. "In little more than a decade, Cassin and Wilson managed to expand the collection from the largest in America to the largest in the world." Cassin worked weekends and evenings at the Academy organizing the arriving bird collections, buying and trading skins, all the while acquiring an encyclopedic knowledge of bird genera. Elliott Coues wrote that Cassin was "the only ornithologist America ever produced who knew any considerable number of Old World birds." In a way he put plumage on the world's opinion of the Academy's position in natural science. Cassin called himself a "closet naturalist" rather than a field naturalist such as Gambel, A.L. Heermann, Richard Kern, Caleb Kennerly, and Robert Kinnicott. More pivotal was the leader in Americana museum progress, Spencer Fullerton Baird, for whom Cassin wrote "the warmest friendship I ever formed."

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Three naturalists, Catesby, Audubon, and Cassin, all published works illustrating North American birds that introduced plants drawn with varying accuracy relating more or less to the habitats of the birds. This side of botanical illustration has been ignored by the historians of the subject. The botany of Catesby's *Natural History* was summarized by Robert L. Wilbur in this journal in 1990. The plant backgrounds of Audubon's plates in *Birds of America* have been occasionally mentioned, but no catalogue has been attempted. Audubon's description and color plate of *Cornus nuttalli* is unique for his having announced the new dogwood before botanists caught up.

Cassin and Audubon both employed plant artists, but Cassin's plant contributions are less significant. Suggestions for the identification of Cassin's background plates:

Plate 1. *Salvia* coccinea [Murr.]
2. *Acer?* For the California woodpecker that stores acorns, *Quercus* would have been appropriate.
3. "*Phlox dummondii,* a beautiful species which is a native of New Mexico and California." This indifferent drawing of *Phlox dummondii* Hook. may relate to the Santa Fe origin of seed grown by Kilvington. Reference to "California" further obscures its history.
7. *Eschscholzia californica* [Cham.]. The wren-tit is uncharacteristically associated with poppy fields.
9. *Opuntia* stylized.
12. "*Nuttallia digitata* of California." Was *Callirhoe digitata* Nutt. of Texas or *Sidalcea malvaeflora* Gray of California intended?
14. "*Microsperma bartonioides*" is *Eucnide bartonioides* Zucc.
20. "A western species of *Ipomoea,* which was raised from seed by our esteemed friend, Mr. Robert Kilvington, of Philadelphia, to whose kindness we are indebted for the figuring of it and other plants for the plates of the present work." *Ipomoea coccinea* var. *hederifolia* (L.) Gray. Robert Kilvington (1803 – 1881), Yorkshire squire, cousin of T.B. Wilson, "well-known florist," was active in the Academy and the Pennsylvania Horticultural Society (Harshberger, *Botanists of Philadelphia* (1899), 188.
22. "*Odontoglossum cervantesii*" [La Llavese & Lexarza] — ask the orchidologist.
23. *Spiraea douglasii* [Hook.] "of western North America."
27. *Zauschneria californica* [Presl].
30. "*Nemophila insignis*" is *Nemophila menziesii* Hook & Arn.
32. "*Habrothamnus fasiculatum* of Mexico" is *Cestrum fasiculatum* Meirs.
34. "*Abronia umbellata*" is perhaps *Abronia villosa* Wats.?
42. "*Vernonia,* from the neighborhood of Santa Fe, New Mexico, and raised from seed by Robert Kilvington, of this city." Could this be an early introduction of Russian knapweed, *Centaurea repens* L.?
47. "A species of *Penstemon* from Texas, raised in the horticultural establishment of Mr. Robert Kilvington, of this city." With some discrepancies, *Penstemon baccarifolius* Hook. Could this have been collected by Charles Wright "from western Texas to El Paso"? (F.W. Pennell, *Acad. Nat. Sci. Phila. Mem.* 1 (1935): 270?
48. "A species of Asclepias from Texas, raised from seed by our friend Mr. Kilvington." *Acerates auriculata* Englem.?

Enjoy a handsome facsimile, enhanced with a naturalist's introduction, at an attractive ransom. Rediscover who met Audubon who met Cassin. Taste Texas.
—*Joseph Ewan, Missouri Botanical Garden, P.O. Box 299, St. Louis, MO 63166-0299, U.S.A.*

BOOKS RECEIVED

WORLD BANK. 1990. **Vitiver Grass. The hedge against erosion** (3rd ed.). (ISBN 0-8213-1405-X, pbk). World Bank, 1818 H Street, N.W., Washington, D.C. 20433. x + 78 pp.

AGRICULTURE AND RURAL DEVELOPMENT DEPT., WORLD BANK. 1991. **Agricultural biotechnology: the next "green revolution"?** (ISSN 0253-7494, pbk). World Bank technical paper 133:x – 51.

ENVIRONMENT DEPARTMENT, WORLD BANK. 1991. **Environmental assessment sourcebook. Volume III. Guidelines for environmental assessment of energy and industry projects.** (ISSN 0253-7494, pbk). World Bank technical paper 139:xiii – 237.

DEJENE, A. and J. OLIVARES. 1991. **Integrating environmental issues into a strategy for sustainable agricultural development.** (ISSN 0253-7494, pbk). World Bank technical paper 146:vi – 32, + 8 maps..

WORLD BANK. 1992. **World development report 1992: Development and the environment.** (ISBN 0-19-520877-3. cloth; ISBN 0-19-5208776-5) Pbk, 308 pp. Oxford University Press, Inc. 200 Madison Ave., New York, NY 10016.

WELLS, M. and K. BRANDON and L. HANNAH. 1992. **People and parks. Linking protected area management with local communities.** (ISBN 0-8213-2053-X, pbk). The World Bank, 1818 H Street, N.W., Washington, D.C. 20433.

SINGH, I. 1990. **The great ascent: The rural poor in South Asia.** (ISBN 0-8018-3954-8). For World Bank by Johns Hopkins University. The World Bank, Publications Dept., J2152, 1818 H Street, N.W., Washington, D.C. 20433. (202)473-7543. $39.95, Pbk, 472 pp. Subjects covered: Agriculture and rural development, poverty, agricultural livestock, forestry, fishery.

COOK, W. 1987. **The wen, the botany, and the Mexican hat. (The adventures of the first women through Grand Canyon on the Nevills Expedition.** Callisto Books, P.O. Box 113, Orangevale, California 95662. Pbk, viii + 151 pp. Illustrated.

ZIMDAHL, R.L. 1989. **Weeds and words (The etymology of the scientific names of weeds and crops).** (ISBN 0-8138-0128-1). Iowa State University Press, Ames, Iowa. Hbk, xix + 125 pp.

MOORE, M. 1989. **Medicinal plants of the desert and canyon West.** (ISBN 0-89013-181-3). Museum of New Mexico Press, P.O. Box 2087, Santa Fe, NM 87504. $18.95, hbk, xiv + 184 pp. Illustrated, color. 1. Medicinal plants—West (U.S.)—Identification. 2. Materia medica, Vegetable.

NABHAN, G.P. 1989. **Enduring Seeds: Native American agriculture and Wild plant conservation.** (ISBN 0-86547-343-9). North Point Press, 850 Talbot Avenue, Berkeley, CA 94706; (415)527-6260. $18.95, hbk, xxiv + 225 pp.

RAVEN, P.H., R.F. EVERT, and S.E. EICHHORN. 1992. **Biology of plants, 5th ed. (ISBN 0-87901-532-2)** Worth Publishers, 33 Irving Place, New York, NY 10003. $59.95, hbk, illustrated, color, xx + 791 pp. Strongly recommended as a text or reference in anyone's library.

BOOK REVIEWS

RICHARDSON, A. 1990. **Plants of southernmost Texas**. Gorgas Science Foundation, Inc., 83 Fort Brown, Brownsville, TX 78520. (ISBN 0-9627293-0-2) $15 ppd, pbk, 298 pp, illustrated.

"Cameron, Hidalgo, and Willacy counties. Whenever possible, ordinary English words are used instead of "botanese." There are some botanical terms which must be used, but they are defined in the glossary and sometimes also in the text. The identification process has been made as easy as possible, and difficult technical characteristics are used only as a last resort."

All 823 native plants (exclusive of grasses) are described and keyed. Despite the absence of this important family of plants the book is very useful.

COMPILED. Forward by P. Stegner. 1990. **The WPA guide to the Monterey Peninsula.** Reprinted by and available from the University of Arizona Press, 1230 North Park Avenue, Suite 102, Tucson, AZ 85719. (ISBN 0-8165-1145-4) $13.95, pbk, 207 pp. 75 illustrations.

"The WPA Guide to the Monterey Peninsula" is a blend of history and self-guided tours of Monterey, Carmel, Pacific Grove, and Big Sur. Included are numerous photos from the '30s and woodcuts by San Francisco engraver Mallett Dean. Also in the book are a chronology of the Monterey Peninsula and a glossary of Spanish names and terms." Chapter 1. The Peninsula; chapter 2. The Three Cities; chapter 3. Shore and Valley; chapter 4. Appendices.

ALCOCK, J. 1990. **Sonoran Desert Summer.** University of Arizona Press, 1230 North Park Avenue, Suite 102, Tucson, AZ 85719, (602)621-3920. (ISBN 0-8165-1150-0). $19.95, hbk, x + 188 pp, illustrated..

"Life and death, "noisy violence, sex, and excitement": it's all there among the birds and animals, the trees, shrubs, and insects that live in the Desert Southwest." The author reveals the fascination of life in this unique environment.

MERTZWEILLER, J.D. (ed.) 1991. **Fiftieth anniversary publication of the Society for Louisiana irises. 1941 – 1991.** Franklin Press, Inc., Baton Rouge, LA. Order from: Society for Louisiana Irises, Box 40175 U.S.L., Lafayette, LA 70504. $10.00. ix + 128.

Contents: Dr. John K. Small (R.A. Bazet), Botanist and Friend; Iris studies in the Gulf States (J.K. Small); Harvesting Iris seeds in the Gulf States (J.K. Small); Salvaging the native American Irises (John K. Small); Vanishing Iris (J.K. Small); Addisonia color plants (J.K. Small and M.E. Eaton); Bazet to the Doctor to Bazet (J.K. Mertzweiller).

Weber, W.A. 1990. **Colorado flora: eastern slope.** (ISBN 0-87081-213-0). University Press of Colorado, P.O. Box 849, Niwot, CO 80544, (303)530-5337. Hbk, xxxviii +396. Illustrated, color.

This is the companion volume to Colorado flora: western slope. Contents: Preface, Introduction, Key to the families, Ferns and Fern allies, Gymnosperms, Angiosperms, Figures, Glossary of terms, Index to common names, Index to genera.

Wittmann, R.C. and W.A. Weber. 1992. **Catalog of the Colorado flora: a biodiversity baseline.** (ISBN 0-87081-243-2). University Press of Colorado, P.O. Box 849, Niwot, CO 80544, (303)530-5337. $34.95, hbk, xiv + 215 pp.

"The *Catalog of the Colorado Flora* accounts for all names used for Colorado vascular plants, lichens, and bryophytes, from 1874 to the present. Lists of synonyms with forwarding addresses are given for names no longer in use, and plants originally described from Colorado specimens dating back to the 1860s are listed with their bibliographic citations and specific data. Introduced (adventive) and endemic species are also noted. References on which Colorado records were based are provided and keyed into a comprehensive bibliography."

Spearing, D. 1991. **Roadside geology of Texas.** (ISBN 0-87842-265-X). Mountain Press Publishing Company, P.O. Box 2399, Missoula, MT 59806, 1-800-234-5308, fax (406)728-1635. $15.95, pbk, illustrations, xiv + 418 pp.

This is the seventeenth title in Mountain Press' Roadside Geology series. "*Roadside Geology of Texas* explains how common geologic processes shaped an molded the landscapes you see today. The geologic panorama of Texas is a wide as the state is big—sweeping from volcanic mesas and thrusting mountains in the west to red canyons of the Panhandle, along tropical sand barriers of the Gulf Coast, and across limestone plateaus in the center of the state." Chapter 1. The big picture, chapter 2. The gulf coast, chapter 3. Central Texas (Hill country, caves, and plateaus), chapter 4. Northeast Texas (Lignite and piney woods, chapter 5. Northcentral Texas (Red beds and Dinosaur tracks), chapter 6. West Texas (Mountain Country), chapter 7. Northwest Texas (The panhandle – High Plains).

Klinka, A., V.J. Krajina, A. Ceska, and A.M. Scagel. 1989. **Indicator plants of coastal British Columbia.** (ISBN 0-7748-0321-5). University of British Columbia Press, #303 – 6344 Memorial Rod, Vancouver, British Columbia V6T 1W5, CANADA. (604)228-3259. $36.95, Tanalin Binding, illustrations, 409 color, 46 tables, 9 figures, 300 pp.

This is a very beautiful identification guide. Contents: Tables, Figures, Acknowledgments,

Introduction, Basic concepts, Concepts and methods related to indicator plants, site attributes and indicator species, Indicator plant analysis, Distribution and ecological characteristics of indicator plants, References.

FOSTER, S. and J.A. DUKE. 1990. **A field guide to medicinal plants: eastern and central North America.** Text by Steven Foster and James A. Duke, line drawings by Roger Tory Peterson, Jim Rose, and Lee Allen Peterson; photographs by Steven Foster. (ISBN 0-395-46722-5, pbk). Houghton Mifflin Company, 2 Park St., Boston, MA 02108. (617)725-5972. $24.95 (hbk), $15.95 (pbk), illustrated, color, xvi + 366 pp.

Another one of those Peterson Field Guides that is pack with information in addition on telling you how to identify the 500 medicinal plants covered. Each plant is illustrated with numerous full color photographs on about half of the plants. This handy pocket book is recommended regardless of whether the medicinal aspect is of interest

HARTZELL, H. JR. 1991. **The yew tree. A thousand whispers (Biography of a species).** (ISBN 0-938493-14-0, pbk). Hulogosi, P.O. Box 1188, Eugene, OR 97440. $19.95, illustrated, photographs, xvi + 319 pp.

Hartzell has brought together in one place an amazing amount of information on one plant. It is a wonderful overview of the yew's history, botany, culture, and use of the compound taxol which is being tested against cancer. Interesting!

FISHER, T.R. 1989. **The vascular flora of Ohio Volume 2: The dicotyledoneae of Ohio. Part 3: Asteraceae.** Text by T. Richard Fisher, original drawings by Sharon Ames Glett. (ISBN 0-8142-0446-5(pt3), hbk). Ohio State University Press, 180 Pressey Hall, 1070 Carmack Road, Columbus, OH 43210-1002. (614)292-6930. $65.00. xiv + 280 pp.

Part three of volume two covers 75 genera and 276 species represented in the Ohio flora. Each species is illustrated and provided with a Ohio distribution map. Ohio floristic workers should find this book useful and necessary.

BRIDSON, G.D.R. (Compiler & Editor) and E.R. Smith (Ed. Asst.) 1991. **B-P-H/S Botanico-Periodicum-Huntianum/Supplementum.** (ISBN 0-913196-54-1, hbk). Hunt Institute for Botanical Documentation, Carnegie Mellon University, Pittsburgh, PA 15213. $103.00 (including phi), 1068 pp.

This is a must book for any serious research library. The following best describes the new *B-P-H/S* and is directly from the introduction. "This work forms both a supplement to and a partial revision of *B-P-H Botanico-Periodicum-Huntianum*, published by the Hunt Institute in 1968. Since *B-P-H* is not fully superseded, the present work is designed as a "key" to the locations of entries in both volumes. *B-P-H* included entries for "more than 12,000 titles" published down to the end of 1967. With the new titles now added, the total number of entries has risen to over 25,000 and the period of coverage is extended to the end of 1990, with the addition of a few new titles from 1991."

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A NEW SPECIES OF *IPOMOEA* (CONVOLVULACEAE) FROM OAXACA, MEXICO

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ABSTRACT

Recent collecting in Mexico has uncovered a novelty in *Ipomoea* (Convolvulaceae), *I. gesnerioides*, from the arid Tehuacán valley of Oaxaca. It is closely related to *I. bombycina* Benth. & Hook., section *Bombycospermum* (Presl) Austin, but differs by producing basally terete stems, mostly terminal inflorescences, and larger, broadly urceolate corollas 3 – 3.5 cm long and 1.5 – 2 cm broad.

RESUMEN

Se reconoce una nueva especie del Valle de Tehuacán, Oaxaca, *Ipomoea gesnerioides*. Parece ser relacionada con *I. bombycina*, sect. *Bombycospermum*, de la cual se distingue por tallos basales rollizos, inflorescencias usualmente terminales y corollas urceoladas, 3 – 3.5 cm de largo.

Ipomoea gesnerioides McDonald sp. nov.

A *Ipomoea bombycinae* caule basale laeve terete ac corollis 3 – 3.5 cm longis 1.5 – 2 cm latis statim diagnoscenda.

Vines lignescent, twining. *Stems* terete, initially erect and straight, becoming twining and contorted, the hypocotyl swollen, succulent, smoothish, terete-ellipsoid, 5 – 8 cm long, to 3 cm in diam., tan to gray, subdermally chlorophyllous, bearing many short shoots at the apex, ascending stems 0.5 – 3 m long, 2 – 12 mm in diam., new growth pale green, villous, old growth tan, bark membranous, glabrous; internodes 1.5 – 2.5 cm long; roots fibrous. *Leaves* petiolate; petioles terete, 0.5 – 3.5 cm long, reduced on terminal, fertile branchlets, puberulent, villous or canescent; lamina broadly elliptic or occasionally somewhat rhombic, 2 – 8 cm long, 1.5 – 5 cm wide, dark green and puberulent above, canescent below, primordially corrugate, margins entire, apex acute or acuminate, base acute or subtruncate, occasionally subcordate on fertile branchlets; venation pinnate. *Inflorescence* a scorpioid pseudoraceme comprised of reduced, congested, single flowered cymes usually at the apex of fertile branches; peduncles wanting; pedicels terete, 2 – 9 mm long, 0.5 – 1 mm in diam., green, puberulent; sepals subequal, ellipsoid, 1.1 – 1.5 cm long, 5 – 7 mm wide, coriaceous, canescent or variably villous, margins entire, apex acute or obtuse; corolla urceolate, basal portion of tube 6 – 8 mm long, 4 – 8 mm in diam., distal portion dilating, 2.5 – 3 cm long, 1.5 – 2 cm broad medially, pale green, limb flaring

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FIG. 1. Fertile shoots of *Ipomoea gesnerioides* based on the holotype. A. Flowering branch. B. Seed. C. Mature fruiting branch.

abruptly, 2.5 – 3 cm wide, interplicae pale green, the exterior pubescent, plical regions purple, glabrous; stamens subequal, 3.0 – 3.5 cm long, white, style surpassing androecium by ca. 2 mm; stigma bilobate, white. *Fruit* a broadly ellipsoid capsule, locules 2, valves 4, tan, chartaceous, 1.1 – 1.3 cm long, 8 – 10 mm wide, glabrous; seeds 4, ellipsoid, 3 – angled, 6 – 7 mm long, 3 – 3.5 mm wide, dark brown, minutely puberulent with dense lanate tufts of hair along angle margins toward hilum, hairs white, to 1 cm long.

TYPE: MEXICO. OAXACA: 10.4 mi W of Santiago Astata on Hwy 200, in scrub-deciduous forest, 9 Mar 1985, *Luckow 2605* (HOLOTYPE: TEX!; ISOTYPES: MEXU!, US!).

Ipomoea gesnerioides most closely approaches *I. bombycina* Benth. & Hook., type species of *Ipomoea* sect. *Bombycospermum* (Presl) D. Austin, by the presentation of

a swollen hypocotyl 1 – 3 cm wide, initially erect stem growth that later becomes twining, somewhat corrugate leaves, scorpioid pseudoracemes, urceolate corollas, and densely lanate seeds. *Ipomoea gesnerioides* is unique among all other *Ipomoea* of Mexico, however, in producing mostly terminal, scorpioid pseudoracemes and large (3 – 3.5 cm long, medially 1.5 – 2 cm in diameter) urceolate corollas with a pale green and purple limb. Flowers of *I. bombycina* are generally born on axillary pseudoracemes (sometimes terminal), and corollas never exceed 2.5 cm in length and 1 cm in diameter. The vegetative features of these two species are also distinctive, *I. bombycina* bearing a rough, furrowed, swollen hypocotyl, while the swollen hypocotyl of *I. gesnerioides* is terete and relatively smooth. Both species are restricted to the tropical deciduous forest of southern Mexico, *I. bombycina* occurring from Jalisco to Guerrero in tropical deciduous forest, and *I. gesnerioides* from its type locality in the arid Tehuacán Valley of Oaxaca.

BOOK REVIEWS

WORLD BANK. 1991. **Forestry. The World Bank's Experience.** (ISBN 1011-0984, pbk). World Bank, 1818 H Street, N.W., Washington, D.C. 20433.

Forestry, The World Bank Experience, is an in depth report on World Bank Financed Forestry Projects from 1949 through 1990. It lists successes and failures, changes in policy and their evolution in the changing economic and environmental situations worldwide.

This is the first Operations Evaluation Study performed on the forestry sector involving some $2 Billion overall. It provides an assessment, interprets the implications of these projects and makes recommendations for the future.—*A. Bowman.*

SOLTIS, P.S., D.E. SOLTIS and J.J. DOYLE (EDS.). 1992. **Molecular Systematics of Plants.** Chapman & Hall an imprint of Routledge, Chapman & Hall, Inc., 29 West 35th Street, New York, NY 10001 (212)244-3336. Paper $32.50, Cloth $93.95. xii + 434 pp.

The book is broken into four main parts: Part I: Molecules and genomes in plant systematics; Part II: Molecular approaches to plant evolution; Part III: Model studies of phylogenetic relationships; Part IV: Theoretical perspectives. And as stated in the preface, the goals of the book are threefold: "(1) to summarize the achievements of plant molecular systematics in its first decade; (2) to illustrate the potential of molecular characters for addressing a variety of phylogenetic and evolutionary questions; and (3) to suggest the appropriate techinque(s) for a given level of systematic inquiry." This is an in-depth look into molecular systematics.

BIRKS, H.H., H.J.B. BIRKS, P.E. KALAND and D. MOE (Eds.) 1988. **The Cultural Landscape—Past, Present and Future.** (ISBN 0 521 34435 2 Hbk). Cambridge University Press, 40 West 20th Street, New York, NY 10011. Price Unknown, xvii + 521 pp.

"The papers in this book describe and trace the developments of cultural landscapes in different climatic and biogeographical regions in Europe. Remnants of traditional land-use still remaining are described, particularly from Western Norway, where traditions have lingered because the rugged topography of the region is inimicable to high-technology." Each of the 55 chapter is by an expert in the field. "The topics cover the documentation of present cultural landscapes, their maintenance and restoration, and the history of the development of cultural landscapes from the Stone Age onwards, linking the intensity of landscape utilization with population dynamics and technological attainments. The disciplines involved include vegetation science, vegetation history, ecology, paleoecology, archaeology, sociology, geography and history. The chapters are based on contributions to the symposium celebrating the centenary of the Botanical Institute of the University of Bergen, held in Sogndal, Western Norway in July 1986.

This interdisciplinary book will be of great interest to a wide readership, comprising landscape ecologists, paleoecologists, plant ecologists, landscape historians, sociologists, archaeologists, geographers and conservationists."

LIATRIS VIRGATA (ASTERACEAE) IN THE SOUTHEASTERN UNITED STATES

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ABSTRACT

Liatris regimontis (Small) Schumann and *L. graminifolia* var. *smallii* (Britton) Fernald & Griscom are two names used for a taxon that is widely distributed in the southeastern United States. Diagnostic features of the type of *Liatris virgata* Nuttall are compatible with those of the holotypes of the two previous taxa. Principal components analysis shows that the type of *L. virgata* is included in the continuous range of morphological variation of a sample of specimens previously determined as *L. regimontis* or *L. graminifolia* var. *smallii*. Nuttall's name has priority and is the correct name for this taxon. The unusual, environmentally induced inflorescence of the type of *L. virgata* probably caused botanists to disregard Nuttall's name for over 100 years.

RESUMEN

Liatris regimontis (Small) Schumann y *L. graminifolia* var. *smallii* (Britton) Fernald & Griscom son dos nombres de un taxon que es ampliamente distribuido en el sudeste de los Estados Unidos. Las caracteristicas diagnosticas del tipo de *Liatris virgata* Nuttall son compatibles a esas de los holotipos de los taxones anteriores. El analisis de los componentes principales muestra que el tipo de *L. virgata* esta incluido dentro del rango de la variabilidad morfologica de un muestreo de los especimenes anteriormente identificados como *L. regimontis* o *L. graminifolia* var. *smallii* por otros investigadores. El nombre de Nuttall tiene la prioridad y es el nombre exacto para este taxon. La florescencia extrana y inducida por el ambiente del tipo de *L. virgata* probablemente causo los botanistas no hacer caso del nombre de Nuttall por mas de cien anos.

INTRODUCTION

A member of *Liatris* Schreber ser. *Graminifoliae* Gaiser, widely distributed in the southeastern United States, currently is named *L. regimontis* (Small) Schumann by some authors and *L. graminifolia* Willd. var. *smallii* (Britton) Fernald & Griscom by others. Examination of the type specimens as well as herbarium collections (DUKE, G, NCSC, NCU, NY, US, USCH) indicates that a name which has seldom been used, *L. virgata* Nuttall, must replace the two names currently used. The objectives of this article are to: (1) present evidence for using the name *Liatris virgata* for this taxon, and (2) emend Nuttall's description of *L. virgata* so that the description more closely conforms to the typical morphology of the species.

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TAXONOMIC HISTORY

Liatris virgata—Nuttall (1834) published the name *Liatris virgata* for material he described as "Remarkable for the decomposition of its racemes and the long leafy pedicels of the flowers. Florets about eight in each calyx." Part of the phyllary description stated "squamis obtusis appressis." He collected his samples in Georgia and North Carolina. Nuttall (1841) modified his description of the phyllaries to "somewhat acute or obtuse" and described the habitat as "In the pine forests of Georgia, and near Newbern, N. Carolina."

Gaiser (1946) placed Nuttall's name in the synonymy of *L. graminifolia* var. *dubia* (Barton) Gray even though the southerly distribution, diffuse inflorescence, and number of flowers per head indicated by Nuttall are not closely compatible with the distribution and morphology that she cited for var. *dubia*. Her key stated that var. *dubia* is "of more general distribution in the northeastern range of the species." Gaiser described the inflorescence as "a fairly dense raceme, but frequently becoming paniculate" and the heads as "10–15 flowered and thus larger than in other varieties."

Fernald (1949) pointed out that the open inflorescence of Nuttall's plant makes it very different from the other elements of var. *dubia*. He treated Nuttall's taxon at the rank of variety, thus publishing the new combination *L. graminifolia* var. *virgata* (Nuttall) Fernald. Fernald indicated that the geographical range of var. *virgata* extended from Georgia to the pine barrens of New Jersey. This range was more extensive than those for all other varieties and species of series *Graminifoliae*.

The names *Liatris virgata* and *L. graminifolia* var. *virgata* are lacking, even from synonymy, in most of the pertinent taxonomic literature for the eastern United States (Britton 1896, 1901; Chapman 1883; Cronquist 1952, 1963, 1980; Godfrey 1948; Gray 1848, 1876, 1884; Robinson and Fernald 1908; Small 1903, 1913, 1933; Strausbaugh & Core 1978). The only exceptions are the recognition of var. *virgata* by Fernald (1950) and the inclusion of the varietal name in synonymy under *L. graminifolia* Willd. by Radford et al. (1968).

Liatris regimontis/L. graminifolia var. smallii—*Liatris regimontis* (Small) Schumann (*Lacinaria regimontis* Small) and *Liatris graminifolia* var. *smallii* (Britton) Fernald & Griscom (*Lacinaria smallii* Britton) were recognized by Gaiser (1946) as distinct; however, her treatment is questionable because she included extraneous material in her circumscription of *L. regimontis* (Stucky & Pyne 1990). Cronquist (1980), recognizing the striking similarity between these plants, combined the two and listed *L. graminifolia* var. *smallii* as a synonym of *L. regimontis*. Numerical analysis (Stucky & Pyne 1990) supported Cronquist's treatment. Additionally, it appears appropriate to treat the taxon as a species rather than a variety. *Liatris regimontis* occurs in the mountains and western Piedmont of Virginia and North Carolina and in the Piedmont and Coastal Plain of South Carolina and Georgia.

HERBARIUM COLLECTIONS

In response to a request for the type of *Liatris virgata* Nuttall, PH loaned a single herbarium sheet on which two specimens were mounted. The handwritten label for the right specimen included no indication of collection location or scientific name. The label for the left specimen was, apparently, in Nuttall's handwriting and included a general location and a scientific name. This left specimen is the lectotype of *L. virgata* [Geo. *T. Nuttall s.n.* (LECTOTYPE: PH!)].

The lectotype is an inflorescence approximately 40 cm long with the rachis broken terminally. The vegetative portion of the plant is not present on the specimen. The flexible definition of "raceme" by Rickett (1955) applies to this inflorescence. This definition specifies monopodial inflorescences in which the flowering sequence is either acropetal or basipetal and in which the lateral elements are either individual flowers or secondary inflorescences. The upper and lower halves of the lectotype exhibit different morphologies. The upper half is composed of a distinct central axis to which an individual head is attached at each node. Peduncle length increases from 1.0 – 2.0 cm near the broken apex to 3.0 – 3.5 cm near the middle of the inflorescence. In the lower half of the inflorescence, the lateral element attached to each rachis node is an ascending raceme with a terminal head and one to four additional heads in its distal portion. Peduncle length is 1 cm or less. Flowering sequence in each lateral raceme is basipetal. Length of lateral racemes increases basipetally along the rachis to a maximum of approximately 2 dm. The number of flowers per head in a sample of five heads was 8 – 11. Phyllaries are acute apically and divergent from the head.

The type of *Lacinaria regimontis* Small [NORTH CAROLINA. Cleveland Co.: King's Mt., 27 – 30 Aug 1894, *J.K. Small s.n.* (HOLOTYPE: NY!; ISOTYPE: NY!)], and the holotype of *Lacinaria smallii* Britton [VIRGINIA. Smyth Co.: along Dickey Creek on Iron Mtn., 2900 ft, 8 Aug 1892, *J.K. Small s.n.* (HOLOTYPE: NY!)] have heads that are morphologically similar to those on the type of *Liatris virgata*. These heads have phyllaries that are acute apically and divergent. There are 8 – 12 flowers per head. The only conspicuous difference when compared with Nuttall's type was the nature of their inflorescences. These are racemes in which the lateral elements are individual heads on peduncles no more than 0.5 cm long. They are more contracted than the type of *L. virgata*.

Only one of the herbarium specimens examined, other than the type of *Liatris virgata*, had been determined as *L. virgata*. This specimen [Hb. Nuttall s.n., NY ex BM], with a label in Nuttall's handwriting, was a portion of a stem bearing 12 heads that had been removed from the rest of the plant. The morphology of the heads was the same as that on the types of *Lacinaria regimontis*, *Lacinaria smallii*, and *Liatris virgata*. This specimen had been annotated by Dr. R.K. Godfrey as *L. graminifolia* (Walt.) Willd. var. *smallii* (Britt.) Fern. & Grisc.

Inflorescences like that on the type of *Liatris virgata* were observed on

TABLE 1. Characters and character states used in PCA.

Pedicel:

1. Pedicel length (mm)
2. Number/3 cm rachis

Head:

3. Orientation: 1, strongly divergent; 2, weakly divergent; 3, strongly ascending

Involucre:

4. Height (mm)
5. Width (mm)

Phyllaries:

6. Outer phyllary planation: 1, flat; 2, cupped; 3, keeled
7. Inner phyllary length (mm)
8. Inner phyllary width (mm)
9. Inner phyllary shape index: length (mm) from base to point of greatest width ÷ total length
10. Inner phyllary apex shape: 1, truncate; 2, obtuse; 3, acute; 4, acuminate
11. Inner phyllary apex reflexion: 1, none; 2, weak; 3, strong
12. Inner phyllary apex planation: 1, flat; 2, involute
13. Extent of scarious margin on inner phyllary: 1, basal 2/3; 2, > basal 2/3 but not around apex; 3, complete

Flowers:

14. Number/head
15. Corolla tube length (mm)
16. Pappus length (mm)

Pubescence:

17. Density on petioles, inflorescence bracts and phyllaries: (Density was assessed on each part and the three assessments summed.): Character states for each part 0, glabrous; 1, sparse; 2, moderate; 3, dense
18. Density on lower & middle stem and rachis: (Density was assessed on each part and the three assessments summed.): Character states for each part 0, glabrous; 1, sparse; 2, moderate; 3, dense

herbarium specimens originally determined as *Liatris gracilis* Pursh and *L. graminifolia* vars. *dubia*, *graminifolia*, and *elegantula* (Greene) Schumann. Collectively, these specimens were from a range extending from Alabama to New Jersey. The majority of these specimens (e.g. *Allard 3827*, NY; *Maxon & Standley* 6, US 640539; *Baker 50*, NY; *Eggleston 5129*, US 586023; *McAtee 3466*, US 1467836; and others lacking collection information), exhibited a rachis that was broken terminally or damaged at some point along its length. On every specimen with a damaged rachis, the portion of the inflorescence below the damaged area included lateral elements that were secondary racemes rather than individual heads.

NUMERICAL TAXONOMY

Principal components analysis (PCA) was conducted to determine if (1) the morphological similarities previously noted among the types of *Liatris virgata*, *Lacinaria regimontis*, and *Lacinaria smallii* were also indicated by a multivariate approach; (2) the types of all three names fall within one continuous field of variation; and (3) *L. graminifolia* var. *dubia* is morphologically compatible with the type of *L. virgata* as concluded by Gaiser (1946). The data set for PCA comprised 18 characters (Table 1) assessed on each of 95 OTU's (specimens). The type specimens of *L. virgata*, *La. regimontis*, and *La. smallii* as well as other specimens of *L. regimontis* and *L. graminifolia* var. *dubia* were included in the PCA. A list of all OTU's for this study can be obtained from the author on request. PCA methodology has previously been described (Stucky & Pyne 1990).

The first two PCA axes explained 41% of the total data variation (Fig. 1). Projection of OTU's onto these axes indicated a relatively strong morphological similarity among the four type specimens. All of these types were included in the continuous range of variation described by the OTU's of *Liatris regimontis*. The range of variation for *L. graminifolia* var. *dubia* was distinct from that of *L. regimontis* and did not include the type of *L. virgata*.

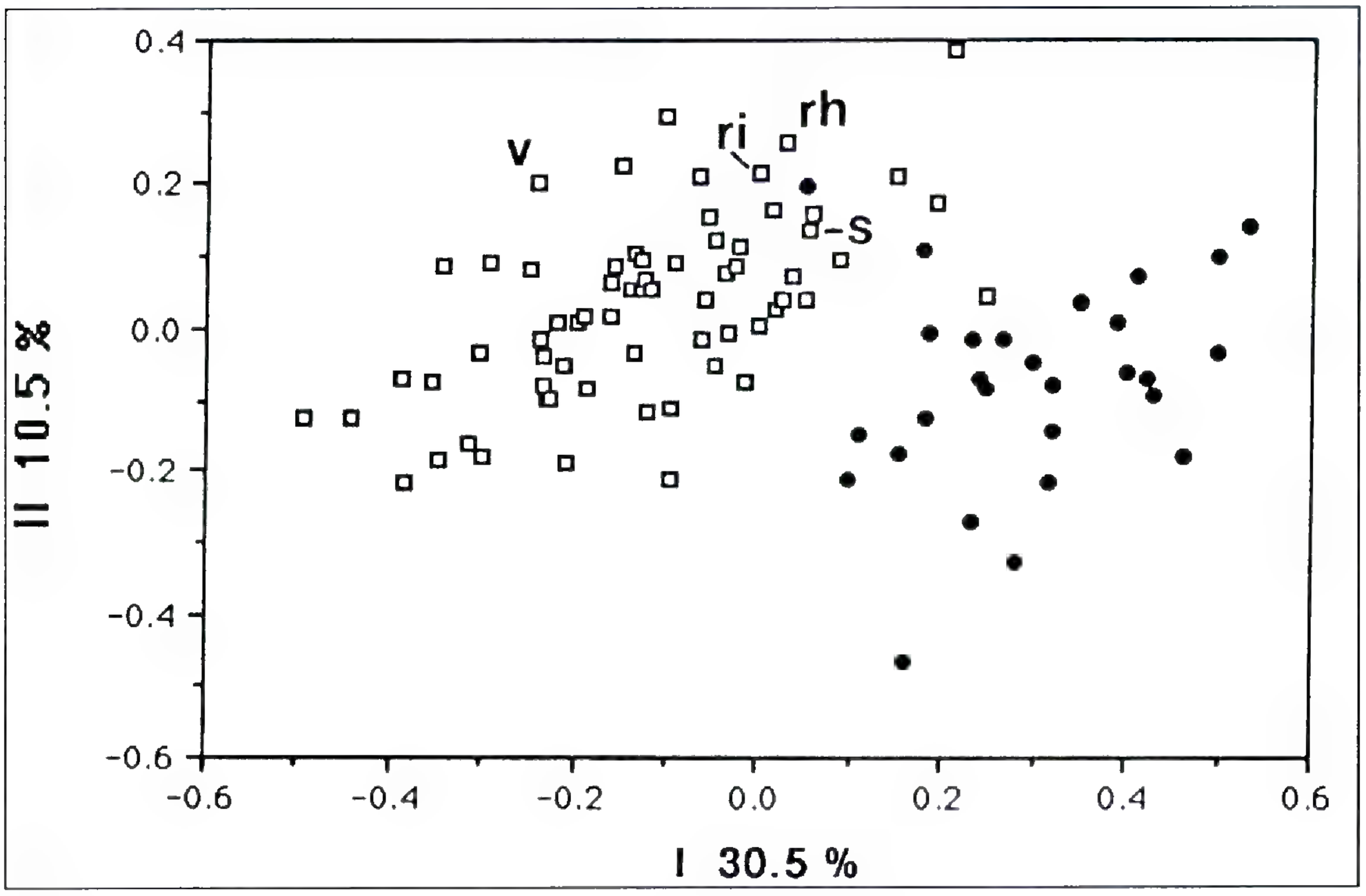

FIG. 1. PCA scores of OTU's on axes I and II. rh and ri = holotype and isotype of *Lacinaria regimontis* Small; s = holotype of *Lacinaria smallii* Britton; v = lectotype of *Liatris virgata* Nuttall. Squares and circles = OTU's of *Liatris regimontis* and *L. graminifolia* var. *dubia*, respectively.

DISCUSSION

The kind of inflorescence which Nuttall (1834) emphasized in his description of *Liatris virgata* commonly occurs in several taxa of ser. *Graminifoliae*, in association with and possibly in response to damage of the inflorescence rachis. Godfrey (1948) reported that growth in a "particularly favorable set of environmental conditions" can also cause unusually diffuse inflorescences in *Liatris*. It appears that the extensive distribution which Fernald (1949) noted for *L. graminifolia* var. *virgata* was based on specimens of several taxa with unusual inflorescences that were environmentally induced. Since the type of *Liatris virgata* Nuttall was among those with both a damaged rachis and an open, compound raceme, it appears that this taxon was based on an unreliable, environmentally induced inflorescence phenotype.

Emended Description of Liatris virgata—Emphasis on "decomposition of racemes" and "long leafy pedicels of the flowers" in Nuttall's description of *Liatris virgata* has, apparently, confused workers for over 100 years; otherwise, authors would have used Nuttall's name for the widely distributed taxon instead of Small's or Britton's names. Descriptions of *L. virgata* should include (1) inflorescence typically a simple raceme with basipetal flowering, peduncles no more than 3.5 – 4.0 cm long, a compound raceme with lateral racemes to 2 dm when the rachis is damaged or when plants occur in unusually favorable habitats, and (2) phyllaries apically divergent and acute, not obtuse as originally described by Nuttall (1834).

PCA shows that the type of *Liatris virgata* Nuttall is not morphologically compatible with *L. graminifolia* var. *dubia*; therefore, Gaiser's treatment of Nuttall's name in the synonymy of var. *dubia* is inappropriate. Type specimens as well as PCA show that *L. virgata* is compatible with material of *L. regimontis*. Godfrey's annotation, "*L. graminifolia* (Walt.) Willd. var. *smallii* (Britt.) Fern. & Grisc." [=*L. regimontis*], of the specimen determined originally by Nuttall as *L. virgata* corroborates PCA results. *Liatris virgata* Nuttall has priority of the various names published for this taxon so it is the correct name. The nomenclature is as follows:

Liatris virgata Nuttall, J. Acad. Nat. Sci. Philadelphia 7:72. 1834. *Liatris graminifolia* Willdenow var. *virgata* (Nuttall) Fernald, Rhodora 51:104. 1949.

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BOOK REVIEW

MASER, CHRIS. 1989. **Forest Primeval. The Natural History of an ancient forest.** Sierra Club Books, San Francisco. Paper $25.00, 230 pp.

Chris Maser says, "I have set out with you (the reader) on a humble journey through a forest of a thousand years so you may see that the forest primeval represents our spiritual and historical roots as human beings."

First Question: Does "forest primeval" refer to the first line of Longfellow's *Evangeline?*

"Humble" can hardly be the proper adjective to describe a thousand year diary in 230 pages. Criticizing Mr. Maser's false modesty is made in the interest of not making my commentary a completely favorable biased panegyric of this extraordinary treatise. Looking for factual or scientific inconsistencies is not my objective since I'm not qualified. I chose to "go with the flow," leaf-like on the powerful current of Maser's philosophical river.

He starts with "the burn" in the year 987 (The fifth day of August!) in order to arrive a thousand years later, 1987, when he began writing. He has a firm scholarly grasp of human (Western Civilization) history and makes the reader comfortable by cleverly intertwining historical events which were happening in the world outside of the forest: perspicacious references to Saint Francis of Assisi, Joan of Arc, The Magna Carta, Columbus, Lief Eriekson, El Cid. A perfect marriage between the two diaries.

Truffles. My favorite food. Strangely and paradoxically I found myself intrigued by the first tentative stirrings of deer mice after "the burn." Their subterranean activities were stimulated by their "gourmet appreciation of the fruiting bodies of fungi, called truffles." I have had a lifelong insatiable appetite for the world's most expensive food. And here I am confronted with Maser's minute and complicated description of the deer mice eating, digesting and propagation of my favorite food in their fecal droppings throughout the forest. My truffled trout will never be the same.

Speaking of minutiae, it is absolutely astounding to plow through the microscopic, eye-level, and telescopic descriptions about the myriad inhabitants, plants and trees in his forest. Did you know that: A flying squirrel "from a height of about 60 feet can glide about 163 feet at the rate of 6 feet per second"? Fawns sniff the metatarsal glands of one another's legs once or twice an hour during the day and as often as six times an hour during the night? But babies are usually born within 30 minutes and in normal labor, there may be as few as 10 muscular contractions; and babies are born in a breech position? Very interesting.

Maser's book was written before Al Gore's "Earth in the Balance," but I believe that they stand close together in their pessimistic predictions on pollution and the inevitable catastrophic conclusion to the ultimate destruction (soon) of Biosphere I. Gore thinks that all technology is evil and wants to abolish all automobiles; our civilization is evil because it is "addicted to the consumption of the Earth (cf. Maser's the economics of extinction.)" According to Gore, America, as a whole, is psychologically dysfunctional and 12,000,000 acres should surely be preserved as the spotted owl's sanctuary. Forget about jobs for human beings.

Maser's treatise is a marvel of environmental advocacy if only because he is an eminently qualified scholar whose encyclopedic, quasi-religious, anthropomorphic musings are worthy of our attention. Also because he predicts cataclysmic consequences of the indiscriminate use of his metaphor of the destruction of the world's environment: the chain saw.

Must read. As a parenthetical, though patently important, observation: you can't have it both ways. Michael Kinsley of Time Magazine has said "You can't have it all." "There is an inevitable trade-off between jobs for human beings and rigid legal requirements of environmental standards." For example: 12,000,000 acres for the exclusive use of the spotted owl versus logging jobs.

You can't have it all.—*A.A. Bernabei.*

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CHARACTER SIGNIFICANCE AND GENERIC SIMILARITIES IN THE PANICEAE (POACEAE: PANICOIDEAE)

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ABSTRACT

A comprehensive study of character significance and generic similarity is presented for genera of the Paniceae. A computerized database consisting of 102 recognized genera recorded 285 characters was constructed and analyzed by the DELTA system. The minimum combination of significant characters required to distinguish each genus within the Paniceae is given in form of diagnostic descriptions. Distribution and use of characters within the diagnosis are discussed. Presence of shared significant characteristics are used to defined generic groups. Morphological similarities among genera within the groups are fully analyzed.

INTRODUCTION

One hundred two (102) genera are recognized in this taxonomic study of the Paniceae R. Br. of the world. The Paniceae is defined here in a broad sense and includes genera placed in apparently closely related or similar tribes such as the Neurachneae Blake, Isachneae Benth., and Melinideae Hitchc. Recognition of the 102 genera is based on studies by Webster (1987, 1988), Webster & Valdez (1988), Webster et al. (1989), and Webster (1991) who presented taxonomic treatments, primarily consisting of keys and descriptions for the Paniceae genera of the world. Recognition of some of the geographically restricted old world genera was based on concepts outlined by Clayton & Renvoise (1986) and Watson & Dallwitz (1988). Objectives of the present paper are to analyze taxonomic significance and distribution of characters in defining genera of the Paniceae and to discuss morphological similarities among recognized genera.

The tribe encompasses approximately 2050 species geographically centered in the tropics and subtropics. Average number of species per genus is 20. *Panicum* (500 species), *Paspalum* (350), and *Digitaria* (250) encompass approximately 1100 species. *Axonopus*, *Urochloa* (including those species commonly placed in *Brachiaria*), *Setaria*, *Isachne*, and *Pennisetum* have about 100 species each for a total of 500. These eight genera account for 73% of the species. Approximately 550 species occur in the remaining 94 genera. Average number of species per genus in this group is 5.9. Eleven genera (*Paspalidium*, *Echinochloa*, *Ichnanthus*, *Eriochloa*, *Sacciolepis*, *Mesosetum*, *Cenchrus*, *Lasiacis*, *Poecilostachys*, *Thrasya*, and *Acroceras*) have

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20 – 40 species. Twenty-one genera have 5 – 15 species. Two to four species are found in 25 genera, and 37 of the 102 genera are monotypic.

Approximately one-half of the genera are geographically restricted to a single continent. *Amphicarpum* is endemic to North America. *Ixophorus*, *Reynaudia*, *Scutachne*, and *Triscenia* occur only in Mesoamerica. Eight genera including *Anthaenantiopsis*, *Centrochloa*, *Oplismenopsis*, *Otachyrium*, *Plagiantha*, *Spheneria*, *Tatianyx*, and *Thrasyopsis* are endemic to South America. Twenty-four genera (*Acritochaete*, *Baptorhachis*, *Chaetopoa*, *Chlorocalymma*, *Cyphochlaena*, *Eccoptocarpha Heteranthoecia*, *Holcolemma*, *Hydrothauma*, *Hylebates*, *Lecomtella*, *Louisiella*, *Megaloprotachne*, *Microcalamus*, *Mildbraediochloa*, *Odontelytrum*, *Oryzidium*, *Poecilostachys*, *Snowdenia*, *Stereochlaena*, *Streptolophus*, *Tarigidia*, *Thyridachne*, and *Yvesia*) occur only in Africa. Asia has three endemic genera (*Limnopoa*, *Sphaerocaryum*, and *Trachys*). Fifteen genera (*Arthragrostis*, *Calyptochloa*, *Chamaeraphis*, *Homopholis*, *Hygrochloa*, *Neurachne*, *Paractaenum*, *Paraneurachne*, *Pseudochaetochloa*, *Thyridolepis*, *Uranthoecium*, *Whiteochloa*, *Xerochloa*, *Yakirra* and *Zygochloa*) occur only in Australia. Finally, one genus, *Dissochondrus*, is endemic to the Pacific Islands. Of the 56 genera mentioned in this paragraph, 37 are monotypic and 12 have 2 – 3 species.

MATERIALS AND METHODS

As in my other publications on genera of the Paniceae, the DELTA system (Dallwitz 1974, 1980) is used in the collection, analysis, and interrogation of taxonomic database. A complete and original set of data was collected for 285 characters for 102 recognized genera. The character list, published on microfiche in Webster (1989), consists of an ordered sequence of characters required for describing and identifying all subtribal categories. Taxonomic data for all characters were gathered based on original studies of specimens for the species of each genus. For most genera, specimens for all species were studied for the collections of data; however, for the larger genera (eg. *Panicum* and *Paspalum*) specimens from representative species were used. The number of specimens used for each species varied. Data in DELTA format were converted to INTKEY format for the generic analysis presented in this paper.

INTKEY is specifically designed for information retrieval and database interrogation. For this analysis characters are weighted relative to how reliable the character is in discriminating among the taxa. Assessment of reliability is based on the degree of consistency within a genus and on how well the character can be applied. For example, if a character is easy to determine and totally consistent within a genus then it is considered to be more reliable than a character difficult to determine and variable among the species of the genus. This weight and the effectiveness of the characters in separating taxa into equal groups were important parameters influencing the following analysis. Additional specific methods are given with each of the following sections.

DIAGNOSTIC DESCRIPTIONS AND CHARACTER SIGNIFICANCE

The following are diagnostic descriptions for the genera. They are diagnostic in that they contain the minimum number of important characters required to separate the genus from all others of the group. For example, the combination of four character states found in the description of *Acritochaete* are unique to that genus. Selection of characters by INTKEY is influenced by variation in other genera and by my concept of character reliability. For example, point of disarticulation is weighted high as a taxonomically reliable character and would be selected over a lower weighted character, even though they may have similar separating power. Thirty-nine of the available 285 characters are used in diagnostic descriptions of 102 recognized genera. The more variable a genus is for highly reliable characters the more characters are required for separation. Number of characters required for each genus varied from 2 (eg. *Cleistochloa* and *Eriochloa*) to 14 in *Panicum*. Other genera requiring a relatively high number of characters are *Acroceras* and *Hymenachne*. An explanation and definition of the terminology used in the following descriptions is given in Webster (1988 & 1989); however, a brief discussion of the terms rachis and quaquaversal seems appropriate. Rachis is used to specify the axis from which the spikelets or spikelet clusters originate. For example, the main axis becomes the rachis when the inflorescence is a spike or raceme. The rachis of a panicle may be either the primary branches or the secondary branches, depending on the degree of branching. Quaquaversal is a type of branching pattern where the branches may originate from any point on the axis. This is in opposition to secund, where the branches originate on one side of the axis, and distichous, where branches originate from two opposite sides of the axis.

Diagnostic Descriptions

1. **Acritochaete** Pilger—Ligule a membrane. Main axis with secund primary branches. Pedicels oblique to the spikelet base. Disarticulation at the spikelet base.

2. **Acroceras** Stapf—Ligule a membrane or a ciliate membrane. Inflorescence a panicle. Rachis terminating in a spikelet. Pedicels truncate at the apex; concave. Disarticulation at the spikelet base. Cleistogamous inflorescence absent. Spikelets adaxial; dorsiventrally compressed. Second glume rounded on the back. Lemma of upper floret indurate; glabrous; muticous or apiculate.

3. **Alloteropsis** Presl—Spikelets abaxial. Lemma of lower floret with a hyaline area at the base. Lemma of upper floret awned.

4. **Amphicarpum** Kunth—Cleistogamous inflorescence present. Spikelets heteromorphic.

5. **Ancistrachne** S.T. Blake—Ligule a ciliate membrane. Primary branches with distichous spikelets. Lemma of upper floret smooth; mucronate.

6. **Anthaenantia** P. Beauv.—Inflorescence a panicle. Primary branches with spreading secondary branches. Disarticulation at the spikelet base). First glume absent. Lemma of upper floret chartaceous; muticous.

7. **Anthaenantiopsis** Pilger—Ligule a ciliate membrane or a fringe of hairs. Inflorescence a panicle. Main axis with distichous primary branches. Pedicels flat. Disarticulation at the spikelet base.

8. **Anthephora** Schreb.—Primary branches reduced to a fascicle of spikelets. Rachis terminating in a spikelet. Disarticulation at the base of the primary branches.

9. **Arthragrostis** Lazarides—Ligule a ciliate membrane. Primary branches with spreading secondary branches. Rachis terminating in a spikelet. Spikelets abaxial. Rachilla pronounced between the florets.

10. **Arthropogon** Nees—Inflorescence a panicle or a raceme. Disarticulation at the spikelet base. Callus differentiated. Spikelets laterally compressed. First glume awned. Lemma of upper floret muticous.

11. **Axonopus** P. Beauv.—Inflorescence a panicle. Primary branches with appressed secondary branches. Rachis terminating in a spikelet. Pedicels concave. Disarticulation at the spikelet base. Cleistogamous inflorescence absent. Spikelets adaxial. First glume absent. Second glume rounded on the back. Lemma of upper floret muticous.

12. **Baptorhachis** Clayton & Renvoise—Ligule a ciliate membrane. Inflorescence a raceme. First glume absent.

13 **Brachiaria** (Trin.) Griseb.—Main axis with secund primary branches. Rachis terminating in a spikelet. Spikelets planoconvex. Lemma of upper floret chartaceous; smooth; muticous.

14. **Calyptochloa** C.E. Hubb.—Cleistogamous inflorescence present. Lemma of upper floret awned.

15. **Cenchrus** L.—Ligule a ciliate membrane or a fringe of hairs. Rachis terminating in a bristle. Disarticulation at the base of the primary branches. Callus flared to form a discoid receptacle. Cleistogamous inflorescence absent. Lemma of upper floret muticous.

16. **Centrochloa** Swallen—Ligule a ciliate membrane. Pedicels convex. Disarticulation at the spikelet base. Callus differentiated.

17. **Chaetium** Nees—Ligule a fringe of hairs. Pedicels oblique to the spikelet base. Lemma of upper floret mucronate to awned.

18. **Chaetopoa** C.E. Hubb.—Disarticulation at the base of the primary branches. First glume awned. Lemma of upper floret mucronate.

19. **Chamaeraphis** R. Br.—Rachis terminating in a bristle. Disarticulation at the base of the primary branches. Spikelets planoconvex to terete.

20. **Chlorocalymma** Clayton—Ligule a membrane. Primary branches reduced to a fascicle of spikelets. Rachis terminating in a bristle. Disarticulation at the base of the primary branches. Callus differentiated.

21. **Cleistochloa** C.E. Hubb.—Cleistogamous inflorescence present. Lemma of upper floret muricate.

22. **Coelachne** R. Br.—Rachis terminating in a spikelet. Fertile florets 2. Lemma of lower floret membranous.

23. **Cyphochlaena** Hack.—Main axis with secund primary branches. Rachis terminating in a spikelet. Disarticulation at the spikelet base. Spikelets heteromorphic.

24. **Cyrtococcum** Stapf—Ligule a membrane. Main axis with quaquaversal primary branches. Disarticulation at the spikelet base. Spikelets laterally compressed. Second glume rounded on the back.

25. **Digitaria** Haller—Ligule a membrane or a ciliate membrane. Inflorescence a panicle. Rachis terminating in a spikelet. Disarticulation at the spikelet base. Spikelets abaxial; planoconvex. Second glume rounded on the back. Lemma of upper floret with flat margins; glabrous; muticous or mucronate.

26. **Dissochondrus** (Hillebr.) Kuntze—Rachis terminating in a bristle. Fertile florets 2.

27. **Eccoptocarpha** Launert—Ligule a fringe of hairs. Disarticulation at the spikelet base. Second glume slightly saccate.

28. **Echinochloa** P. Beauv.—Ligule a fringe of hairs or absent. Inflorescence a panicle. Rachis terminating in a spikelet. Disarticulation at the spikelet base. Cleistogamous inflorescence absent. First glume encircling the spikelet base. Rachilla not pronounced between the florets. Second glume rounded on the back. Lemma of upper floret indurate; smooth; glabrous; muticous.

29. **Echinolaena** Desv.—Ligule a ciliate membrane or a fringe of hairs. Rachis terminating in a spikelet. Pedicels flat to convex. Disarticulation at the spikelet base. Rachilla pronounced between the florets. Lemma of upper floret muticous.

30. **Entolasia** Stapf—Ligule a fringe of hairs. Disarticulation at the spikelet base. Cleistogamous inflorescence absent. Rachilla not pronounced below the second glume. Lemma of upper floret hairy.

31. **Eriochloa** Kunth—First glume fused with the callus to form a cuplike structure. Lemma of upper floret mucronate or awned.

32. **Heteranthoecia** Stapf—Rachis terminating in a spikelet. Fertile florets 2. Lemma of lower floret chartaceous.

33. **Holcolemma** Stapf & C. E. Hubb.—Ligule a membrane. Disarticulation at the spikelet base. First glume inflated at the base. Second glume rounded on the back. Lemma of lower floret with the area between the central nerve and the first lateral nerve thinner in texture than the rest of the structure.

34. **Homolepis** Chase—Ligule a membrane. Primary branches with spreading secondary branches. Disarticulation at the spikelet base. Lemma of upper floret chartaceous to coriaceus; with flat margins.

35. **Homopholis** C.E. Hubb.—Ligule a membrane. Inflorescence a panicle.

Rachis terminating in a spikelet. Disarticulation at the spikelet base. Spikelets abaxial; laterally compressed to dorsiventrally compressed. Second glume rounded on the back. Lemma of lower floret consistent in texture. Lemma of upper floret with flat margins; muticous or mucronate.

36. **Hydrothauma** C.E. Hubb.—Ligule a membrane. Inflorescence a panicle. Rachis terminating in a spikelet. Disarticulation at the spikelet base. Spikelets abaxial. Lemma of lower floret consistent in texture. Lemma of upper floret chartaceous; muticous.

37. **Hygrochloa** Lazarides—Plants monoecious. Spikelets heteromorphic.

38. **Hylebates** L. Chippindall—Ligule a ciliate membrane. Inflorescence a panicle. Primary branches with spreading secondary branches. Rachis terminating in a spikelet. Spikelets dorsiventrally compressed. First glume present; not encircling the spikelet base. Lemma of upper floret muticous.

39. **Hymenachne** P. Beauv.—Ligule a membrane or a ciliate membrane. Inflorescence a panicle. Primary branches with appressed secondary branches. Rachis terminating in a spikelet. Disarticulation at the spikelet base. Cleistogamous inflorescence absent. Spikelets adaxial. First glume encircling the spikelet base. Second glume rounded on the back. Lemma of upper floret membranous to chartaceous; with flat margins; glabrous; muticous.

40. **Ichnanthus** P. Beauv.—Inflorescence a panicle. Rachis terminating in a spikelet. Pedicels concave. Disarticulation at the spikelet base. Cleistogamous inflorescence absent. First glume encircling the spikelet base. Rachilla pronounced between the florets. Second glume rounded on the back. Lemma of upper floret glabrous; with basal scars or appendages; muticous.

41. **Isachne** R. Br.—Rachis terminating in a spikelet. Fertile florets typically 2. Lemma of lower floret cartilaginous.

42. **Ixophorus** Schlecht.—Ligule a membrane. Rachis terminating in a bristle. Lemma of upper floret mucronate.

43. **Lasiacis** (Griseb.) Hitchc.—Ligule a membrane. Rachis terminating in a spikelet. Disarticulation at the spikelet base. Spikelets terete.

44. **Lecomtella** A. Camus—Plants andromonoecious. Inflorescence a panicle. Rachis terminating in a spikelet.

45. **Limnopoa** C.E. Hubb.—Inflorescence a raceme. Disarticulation above the lower glume.

46. **Louisiella** C.E. Hubb. & Leonard—Ligule a ciliate membrane. Inflorescence a panicle. Main axis with quaquaversal primary branches. Rachis terminating in a spikelet. Disarticulation at the spikelet base. First glume not encircling the spikelet base. Lemma of upper floret chartaceous; with involute margins; muticous.

47. **Megaloprotachne** C.E. Hubb.—Spikelets planoconvex. Lemma of upper floret apiculate.

48. **Melinis** P. Beauv.—Ligule a fringe of hairs. Inflorescence a panicle. Main

axis with quaquaversal primary branches. Primary branches with spreading secondary branches; with spikelets neither secund nor distichous. Disarticulation at the spikelet base. Callus not differentiated. Spikelets laterally compressed. First glume present. Lemma of upper floret hyaline to membranous.

49. **Mesosetum** Steud.—Inflorescence a raceme. Pedicels oblique to the spikelet base. Spikelets adaxial.

50. **Microcalamus** Franch.—Ligule a ciliate membrane. Rachis terminating in a spikelet. Rachilla pronounced between the florets. Lemma of upper floret indurate; with flat margins; muticous.

51. **Mildbraediochloa** Butzin—Spikelets laterally compressed. Lemma of upper floret awned.

52. **Neurachne** R. Br.—Inflorescence a raceme. Disarticulation at the spikelet base. Callus differentiated. Spikelets abaxial. Lemma of upper floret hyaline to membranous.

53. **Odontelytrum** Hack.—Ligule a membrane. Rachis terminating in a bristle. Disarticulation at the base of the primary branches. Callus not differentiated. Spikelets adaxial.

54. **Oplismenopsis** Parodi—Ligule a ciliate membrane. Inflorescence a panicle. Primary branches with appressed secondary branches. Rachis terminating in a spikelet. Pedicels concave. Disarticulation at the spikelet base. Callus not differentiated. First glume awned. Lemma of upper floret muticous.

55. **Oplismenus** P. Beauv.—Main axis with secund primary branches. First glume awned. Lemma of upper floret mucronate.

56. **Oryzidium** C.E. Hubb. & Schweick.—Ligule a fringe of hairs. Inflorescence a panicle. Main axis with quaquaversal primary branches. Rachis terminating in a spikelet. Disarticulation at the spikelet base. Cleistogamous inflorescence absent. Rachilla pronounced between the florets. Lemma of upper floret chartaceous; glabrous; muticous.

57. **Otachyrium** Nees—Ligule a membrane or a ciliate membrane. Inflorescence a panicle. Main axis with quaquaversal primary branches. Rachis terminating in a spikelet. Pedicels concave. Disarticulation at the spikelet base. Cleistogamous inflorescence absent. Second glume gibbose or rounded on the back. Lemma of lower floret with a hyaline area at the base. Lemma of upper floret glabrous; muticous.

58. **Ottochloa** Dandy—Ligule a ciliate membrane. Lemma of upper floret muricate; with involute margins; mucronate.

59. **Panicum** L.—Ligule a membrane or a ciliate membrane. Inflorescence a panicle. Rachis terminating in a spikelet. Pedicels cupuliform at the apex; concave. Disarticulation at the spikelet base. Cleistogamous inflorescence absent. Spikelets adaxial; dorsiventrally compressed. Rachilla pronounced between the florets or not pronounced between the florets. Second glume rounded on the back. Lemma of upper floret cartilaginous; glabrous; muticous.

60. **Paractaenum** P. Beauv.—Main axis with distichous primary branches. Disarticulation at the base of the primary branches. Lemma of upper floret cartilaginous.

61. **Paraneurachne** S.T. Blake—Inflorescence a raceme. Pedicels oblique to the spikelet base. Lemma of upper floret indurate.

62. **Paratheria** Griseb.—Disarticulation at the base of the primary branches. Cleistogamous inflorescence present.

63. **Paspalidium** Stapf—Main axis with distichous primary branches or with secund primary branches. Rachis terminating in a bristle. Disarticulation at the spikelet base.

64. **Paspalum** L.—Pedicels flat or convex. Disarticulation at the spikelet base. Spikelets planoconvex. Lemma of upper floret indurate; smooth or striate; muticous.

65. **Pennisetum** Rich.—Ligule a ciliate membrane or a fringe of hairs. Rachis terminating in a bristle. Disarticulation at the base of the primary branches. Callus not flared to form a discoid receptacle. Cleistogamous inflorescence absent. Lemma of upper floret muticous.

66. **Plagiantha** Renv.—Ligule a ciliate membrane. Inflorescence a panicle. Primary branches with spreading secondary branches. Disarticulation at the spikelet base. Lemma of lower floret membranous; with a central longitudinal groove.

67. **Poecilostachys** Hack.—Ligule a membrane. Main axis with secund primary branches. Disarticulation at the spikelet base. Spikelets adaxial; laterally compressed.

68. **Pseudechinolaena** Stapf—Spikelets laterally compressed. Second glume gibbose.

69. **Pseudochaetochloa** Hitchc.—Plants andromonoecious. Lemma of upper floret mucronate.

70. **Pseudoraphis** Griff.—Inflorescence a panicle or a raceme. Rachis terminating in an unmodified naked point. Disarticulation at the spikelet base or at the base of the primary branches. Rachilla pronounced between the florets.

71. **Reimarochloa** Hitchc.—Second glume absent. Disarticulation at the base of the primary branches.

72. **Reynaudia** Kunth—Ligule a fringe of hairs. Inflorescence a panicle. Disarticulation at the spikelet base. Spikelets laterally compressed. First glume awned. Second glume rounded on the back. Lemma of upper floret muticous. Stamens 2.

73. **Rhynchelytrum** Nees—Ligule a fringe of hairs. Inflorescence a panicle. Main axis with secund primary branches. Disarticulation at the spikelet base. Spikelets laterally compressed.

74. **Sacciolepis** Nash—Second glume saccate. Lemma of upper floret scabrous.

75. **Scutachne** Hitchc. & Chase—Ligule a fringe of hairs. Inflorescence a panicle. Rachis terminating in a spikelet. Disarticulation at the spikelet base. Cleistogamous inflorescence absent. First glume encircling the spikelet base. Second glume rounded on the back. Lemma of upper floret with flat margins; glabrous; muticous. Palea of upper floret not enclosed at the apex.

76. **Setaria** P. Beauv.—Main axis with quaquaversal primary branches. Rachis terminating in a bristle. Disarticulation at the spikelet base. Fertile florets 1. Lemma of lower floret consistent in texture. Lemma of upper floret muticous.

77. **Setariopsis** Scribn. & Millsp.—Rachis terminating in a bristle. Disarticulation at the spikelet base. Lemma of lower floret with a hyaline area at the base.

78. **Snowdenia** C.E. Hubb.—Inflorescence a raceme. Pedicels convex. Lemma of upper floret membranous.

79. **Sphaerocaryum** Hook. f.—Inflorescence a panicle. Disarticulation above the lower glume. Fertile florets 1. Lemma of upper floret hairy.

80. **Spheneria** Kuhlm.—Ligule a membrane. Main axis with distichous primary branches. Pedicels oblique to the spikelet base. Disarticulation at the spikelet base.

81. **Spinifex** L.—Flowering culms with inflorescences densely clustered in a spatheate panicle. Inflorescence a raceme or a spike.

82. **Stenotaphrum** Trin.—Ligule a ciliate membrane. Disarticulation at the nodes of the main axis or at the base of the inflorescence.

83. **Stereochlaena** Hack.—Ligule a ciliate membrane. Inflorescence a panicle. Spikelets planoconvex. Lemma of upper floret chartaceous; minutely muricate; muticous.

84. **Streptolophus** Hughes—Ligule a membrane. Rachis terminating in a bristle. Disarticulation at the base of the primary branches. Lemma of upper floret muricate.

85. **Streptostachys** Desv.—Ligule a fringe of hairs or absent. Disarticulation at the spikelet base. Cleistogamous inflorescence absent. Lemma of upper floret indurate; hairy.

86. **Tarigidia** Stent—Main axis with quaquaversal primary branches. Rachis terminating in a spikelet. Disarticulation at the base of the primary branches. Spikelets planoconvex. Second glume present.

87. **Tatianyx** Zuloaga & Soderstrom—Inflorescence a panicle. Pedicels oblique to the spikelet base. Disarticulation at the spikelet base. Lemma of lower floret with a hyaline area at the base. Lemma of upper floret muticous.

88. **Thrasya** Kunth—Ligule a membrane. Main axis with secund primary branches. Lemma of lower floret membranous; with a hyaline area at the base or with the area between the central nerve and the first lateral nerve thinner in texture than the rest of the structure.

89. **Thrasyopsis** Parodi—Ligule a membrane and a fringe of hairs. Inflores-

cence a panicle. Pedicels flat. Disarticulation at the spikelet base. Lemma of lower floret cartilaginous to indurate. Lemma of upper floret glabrous; muticous.

90. **Thuarea** Pers.—Plants monoecious or andromonoecious. Disarticulation at the base of the inflorescence.

91. **Thyridachne** C.E. Hubb.—Ligule a membrane. Inflorescence a panicle. Rachis terminating in a spikelet. Disarticulation at the spikelet base. Spikelets abaxial. First glume encircling the spikelet base. Lemma of lower floret with the area between the central nerve and the first lateral nerve thinner in texture than the rest of the structure.

92. **Thyridolepis** S.T. Blake—Ligule a fringe of hairs. Inflorescence a raceme. Spikelets planoconvex. Lemma of upper floret chartaceous to cartilaginous.

93. **Triscenia** Griseb.—Inflorescence a panicle. Main axis with distichous primary branches. Disarticulation at the spikelet base. Spikelets adaxial. Lemma of upper floret hyaline to membranous.

94. **Trachys** Pers.—Rachis terminating in a spikelet. Disarticulation at the nodes of the main axis or at the nodes of the primary branches.

95. **Tricholaena** Schult.—Inflorescence a panicle. Main axis with distichous primary branches or with secund primary branches. Primary branches with spreading secondary branches. Rachis terminating in a spikelet. Callus minutely differentiated. Spikelets dorsiventrally compressed.

96. **Uranthoecium** Stapf—Disarticulation at the nodes of the main axis. Lemma of upper floret awned.

97. **Urochloa** P. Beauv.—Ligule a fringe of hairs. Inflorescence a panicle. Rachis terminating in a spikelet. Disarticulation at the spikelet base. Cleistogamous inflorescence absent. First glume not fused with the callus. Rachilla not pronounced between the florets. Second glume rounded on the back. Lemma of upper floret rugose; with involute margins; glabrous.

98. **Whiteochloa** C.E. Hubb.—Plants dioecious. Rachis terminating in a spikelet.

99. **Xerochloa** R. Br.—Flowering culms with inflorescences in a spatheate raceme. Inflorescence a spike or a solitary spikelet.

100. **Yakirra** Lazarides & R. Webster—Plants hermaphroditic. Ligule a fringe of hairs. Inflorescence a panicle. Rachis terminating in a spikelet. Disarticulation above the lower glume or at the spikelet base. Cleistogamous inflorescence absent. Rachilla pronounced between the florets. Fertile florets 1. Lemma of upper floret indurate; glabrous; muticous.

101. **Yvesia** A. Camus—Ligule a fringe of hairs. Rachis terminating in a spikelet. Disarticulation at the spikelet base. Cleistogamous inflorescence absent. First glume not fused with the callus; absent. Lemma of upper floret mucronate.

102. **Zygochloa** S.T. Blake—Plants dioecious. Inflorescence a solitary spikelet.

Character Significance

An assessment of character significance is based on how well a character separates among the taxa and its importance for identification of the taxa. For example, a character which does not appear in the diagnostic descriptions would be considered insignificant relative to one appearing numerous times. Furthermore, a character appearing in a relatively high percentage of the descriptions would be considered more significant than one appearing in a low percentage. The following paragraphs present a discussion of the significance of characters and the distribution of the character states for the taxa.

Plant sexuality (hermaphroditic, dioecious, etc.) is required for identification of seven genera (*Hygrochloa, Lecomtella, Pseudochaetochloa, Thuarea, Whiteochloa, Yakirra* and *Zygochloa*). Only two characters related to vegetative features of the plant are used in the results. The first relates to the branching pattern subtending the inflorescences. In *Spinifex*, culms are branched forming a spatheate panicle and in *Xerochloa* the branching forms a spatheate raceme. The second vegetative characteristic is whether the ligule is a membrane, ciliate membrane, fringe of hairs, or absent. This character is required in 51 of the descriptions. A membrane is exclusively found in 21 genera and a fringed membrane in 18 genera. A fringe of hairs is characteristic of 36 and the ligule absent only in *Echinochloa*.

Eleven characters of the inflorescence are used for identification of the genera. Type of inflorescence (panicle, raceme, spike, or solitary) is used in 43 descriptions. Most genera possess some variation of panicle. However, nine genera (*Baptorhachis, Calyptochloa, Limnopoa, Mesosetum*, *Neurachne*, *Paraneurachne*, *Snowdenia*, *Thuarea*, *Thyridolepis*) have only racemes and one genus, *Zygochloa*, is described as having a solitary spikelet as the inflorescence. No genus is characterized as having only a spike inflorescence. Arrangement of primary branches on the main axis of the inflorescence (distichous, secund, or quaquaversal) is of diagnostic importance in 20 genera. The quaquaversal arrangement is most common but distichous or secund primary branches are found in 28 taxa. Whether secondary inflorescence branches are appressed, spreading or reduced to a fascicle of spikelets was used in 12 descriptions. Approximately one-half of the genera have exclusively appressed secondary branches, whereas 13 genera are spreading only. Exclusive reduction of branches to a fascicle of spikelets is found in seven genera (*Anthephora*, *Cenchrus*, *Chlorocalymma*, *Odontelytrum*, *Pennisetum*, *Streptolophus* and *Trachys*). Arrangement of spikelets or secondary branches on primary branches (secund, distichous, and quaquaversal) is used in the descriptions of *Ancistrachne* and *Melinis*. This character has limited taxonomic value especially with the open inflorescence form. One of the most taxonomically significant characters of the Paniceae is presence or absence of bristles. This character appears in 46 descriptions. Seventy-six genera have spikelets terminat-

ing the branches and 26 possess some variation of a bristle. *Holcolemma* and possibly *Pseudochaetochloa* are the only genera variable for this character. The pedicel apex has modifications which are taxonomically significant. Whether or not the pedicel apex is differentiated is significant and related to point of disarticulation. The pedicel apex is not differentiated in those genera where the primary point of disarticulation is not at the base of the spikelet. For example, in *Cenchrus* the pedicel apex cannot be comparatively described. For those genera commonly placed in the Isachneae, where disarticulation is above the glumes, the pedicel apex is not differentiated and clearly different from other genera of the Paniceae. Three characteristics of the pedicel apex are used in the descriptions. Shape of the pedicel apex (truncate, discoid and cupuliform) is taxonomically significant for the genera and especially within *Digitaria*; however, occasionally the states are difficult to determine. Thirteen genera are exclusively truncate (eg. *Acroceras* and *Paspalum*), 35 discoid (eg. *Eriochloa* and *Setaria*), and 22 cupuliform (eg. *Panicum* and *Entolasia*). The remaining 33 genera are variable for these states. Angle of disarticulation (perpendicular or oblique) with the axis of the pedicel is required in six descriptions. *Acritochaete*, *Chaetium*, *Mesosetum*, *Paraneurachne*, *Spheneria*, and *Tatianyx* are exclusively oblique at the pedicel apex, whereas the remaining genera have the typical perpendicular morphology. For taxa where the pedicel apex is differentiated, the apex can be concave, flat or convex. This character is used in 12 descriptions. As expected, the most common state is concave with 63 genera (eg. *Panicum* and *Setaria*). A flat pedicel apex is found exclusively in eight genera (eg. *Oplismenus*, *Pseudoraphis*), and two genera are exclusively convex (*Centrochloa* and *Snowdenia*). *Echinolaena*, *Paspalum*, *Thrasya* are flat to convex. This character is particularly useful for separating *Paspalum* from otherwise similar genera.

Point of disarticulation occurs in 65 descriptions and is taxonomically the most reliable character within the Paniceae. Disarticulation is exclusively above the glumes only in the Isachneae. The most common state which is found in 69 genera is disarticulation exclusively at the spikelet base. Twelve genera disarticulate at the base of the primary branches of the inflorescence. *Uranthoecium* disarticulates at nodes of the main axis. *Thuarea* and *Xerochloa* disarticulate at the base of the inflorescence. No genera disarticulate exclusively at culm nodes; however, this state can occur in *Calyptochloa*, *Spinifex* and *Zygochloa*. Disarticulation at some point below the primary branches is restricted to genera occurring in Australia. Morphological differentiation at the point of disarticulation is referred to as the callus. This character occurs in eight descriptions. The callus is differentiated in 21 genera (see *Cenchrus* and *Spheneria*). Modifications of the callus include whether it is prolonged as in *Centrochloa*, flared as in *Cenchrus*, oblique as in *Paratheria* and *Chaetium*, or hairy as in *Neurachne* and *Arthropogon*. Relative length and color of the callus hairs has limited taxonomic significance.

Presence of absence of cleistogamous inflorescences is used in 20 descriptions. The North American genus *Amphicarpum* and three Australian genera (*Calyptochloa*, *Cleistochloa* and *Paratheria*) possess cleistogamous inflorescences. Cleistogamous spikelets do occur in a number of other genera. In all four genera cleistogamous spikelets are morphologically different from chasmogomous spikelets. *Amphicarpum* is the only genus with a subterranean cleistogamous inflorescence.

Three general characters of the spikelets are included in the descriptions. Presence or absence of morphologically different spikelets was used in three descriptions. Truly heteromorphic spikelets are characteristic of *Amphicarpum*, *Cyphochlaena* and *Hygrochloa*. Orientation of spikelets to the flowering axis or rachis is required in 15 descriptions. Even though this character has significant evolutionary implications its taxonomic value is limited because it is frequently difficult or impossible to determine especially when the inflorescence is open with spreading secondary branches. This character is also difficult to determine when the rachis is modified producing a spikelet cluster as in *Cenchrus*. However, for many genera (eg. *Digitaria* and *Paspalum*) the character is very useful. The terms abaxial and adaxial are used to define whether the first glume or lemma of the lower floret is 180 degrees from the rachis or whether the first glume or lemma of the lower floret faces the rachis. Approximately 1/2 of the genera fall into each category. Spikelet compression is used in 22 descriptions and is generally a reliable character. The most common state is dorsiventrally compressed and exclusively found 56 genera. Lateral compression is found in 21 genera (eg. *Melinis* and Cyrtococcum). Twelve taxa including *Baptorhachis*, *Brachiaria*, *Digitaria*, *Hygrochloa*, *Megaloprotachne*, *Paraneurachne*, *Paspalum*, *Reimarochloa*, *Stereochlaena*, *Tarigidia*, *Thyridolepis* and *Uranthoecium* are exclusively planoconvex. Only one genus, *Lasiacis*, is recorded as exclusively terete.

Five characteristics of the first glume are used in the descriptions. Presence or absence of the first glume is found in 6 descriptions. Eighty-one genera always possess a first glume. Complete absence of a first glume is characteristic of eight genera (*Anthaenantia*, *Axonopus*, *Baptorhachis*, *Centrochloa*, *Reimarochloa*, *Spheneria*, *Tricholaena* and *Yvesia*). Thirteen genera are variable for this character. Fusion of the first glume with the callus is characteristic of *Eriochloa* but also found to a limited degree in *Thrasya*. Significant fusion is not found in the remaining genera. Whether or not the first glume encircles the spikelet base is a significant character but rarely used by taxonomists. This character appears in seven descriptions. The first glume encircles the spikelet base in 36 genera (eg. *Panicum* and *Echinochloa*) and does not encircle the spikelet base in 55 genera (eg. *Digitaria* and *Neurachne*). The remaining 11 genera either lack the first glume or is variable for this character. Pronounced presence of an inflated base on the first glume is found in *Holcolemma*, *Lasiacis* and *Setariopsis*, but only used in the description of *Holcolemma*.

The final characteristic of the first glume used in the diagnostic descriptions is whether an awn is present. An awned first glume is found exclusively in *Arthropogon*, *Chaetium*, *Chaetopoa*, *Cyphochlaena*, *Oplismenopsis*, *Oplismenus* and *Reynaudia*. This character is used in five of the descriptions. An awn is never found in 69 genera and variable in *Anthephora*, *Arthragrostis*, *Echinolaena*, *Mesosetum*, *Paraneurachne* and *Tarigidia*.

Whether the rachilla is pronounced between the glumes or between the florets occurs in 11 descriptions. A pronounced rachilla between the glumes is found exclusively in 19 genera (eg. *Hymenachne* and *Oryzidium*) and not found in 69 genera. It is variable for the remaining 14 genera. For example, in *Digitaria* section Trichachne (Stapf) Henrard this portion of the rachilla is present but not present in section *Digitaria*. The rachilla pronounced between florets is exclusively present in 15 genera (eg. *Ichnanthus* and *Eccoptocarpha*) and not found in 79. Additional modifications of the rachilla between the florets include whether it is straight (eg. *Limnopoa*) or geniculate (eg. *Ichnanthus*), whether it is filiform (eg. *Arthragrostis*) or swollen (eg. *Yakirra*), presence of lateral appendages (eg. *Ichnanthus*), and length of the rachilla (relatively long in *Oryzidium* and short in *Calyptochloa*).

Two characters of the second glume are used in the descriptions. Whether the second glume is present or absent is found in descriptions of *Tarigidia* and *Reimarochloa*, which is the only genus where the second glume is exclusively absent. The second glume is present or absent in the African genera, *Baptorhachis* and *Stereochlaena*. Whether the second glume is saccate, gibbose or simply rounded is found in 17 of the descriptions. A saccate second glume is exclusively found in *Eccoptocarpha* and *Sacciolepis*. A gibbose second glume is characteristic of *Pseudechinolaena*. The remaining genera are simply rounded on the back except for *Digitaria* which is variable due to variation found in section *Gibbosae* Henrard.

The number of fertile florets is found in seven of the diagnostic descriptions and primarily included here due to the inclusion of the genera traditionally placed in the Isachneae. Most (96) of the genera possess only one fertile floret. Two female fertile florets are found in *Coelachne*, *Heteranthoecia* and *Isachne*. *Dissochondrus* is variable from 1 – 3 for this character.

Three characteristics of the lower floret are used in the descriptions. Texture of the lower lemma occurs in six descriptions. The most common texture for these genera is membranous, an exclusive characteristic of 56 genera. *Centrochloa*, *Chaetium*, *Megaloprotachne*, *Oryzidium*, *Reynaudia* and *Spheneria* possess a hyaline or membranous lemma, but only *Chaetopoa* is exclusively hyaline. Eight genera (*Heteranthoecia*, *Lasiacis*, *Otachyrium*, *Paraneurachne*, *Pseudechinolaena*, *Rhynchelytrum*, *Uranthoecium* and *Zygochloa*) are characterized by a chartaceous lower lemma. A cartilaginous or indurate lower lemma is found in 12 genera (eg. *Chamaeraphis*, *Setariopsis* and *Xerochloa*). Frequently, when the lower lemma is relatively thick in

texture or the spikelets surrounded by protective structures the texture of the upper lemma is relative thin (see *Cyphochlaena*). Presence of a relatively thin area at the base of the lower lemma or a relatively thin central groove is a character used in 10 of the descriptions. Typical morphology for this character is the absence of these variations and found in 89 genera. A hyaline area at the base of the lower lemma occurs in nine taxa including *Alloteropsis*, *Hygrochloa*, *Otachyrium*, *Pseudechinolaena*, *Setariopsis*, *Tatianyx*, *Thrasya*, *Whiteochloa* and *Xerochloa*. A central relatively thin groove occurs in *Holcolemma*, *Megaloprotachne*, *Mesosetum*, *Thrasya*, *Thrasyopsis*, *Thyridachne* and *Uranthoecium*. These variations are frequently correlated with presence of well developed stamens in the lower floret.

Six characters of the upper floret are used in the descriptions. Texture of the upper lemma occurs in 22 descriptions. The most common character state for the genera is chartilaginous to indurate which occurs in 63 genera. A hyaline upper lemma is found exclusively in *Chaetopoa*, *Cyphochlaena*, *Mildbraediochloa* and *Reynaudia*. A membranous upper lemma occurs exclusively in *Chamaeraphis*, *Coelachne*, *Snowdenia* and *Sphaerocaryum*. The remaining 32 genera are variable for this character. For example, six genera are membranous or chartaceous. Modification of the margins of the upper lemma occurs in nine descriptions. Forty-nine genera have flat margins and 47 possess involute margins. The remaining six genera (*Alloteropsis*, *Axonopus*, *Calyptochloa*, *Pennisetum*, *Stenotaphrum* and *Uranthoecium*) are variable for these states. Revolute or convolute margins are not found in the Paniceae. Whether the upper lemma is hairy or glabrous is used in 15 descriptions. The most typical state is glabrous which is exclusive for 89 genera. A hairy upper floret is exclusively found in *Amphicarpum*, *Entolasia*, *Heteranthoecia*, *Limnopoa*, *Sphaerocaryum* and *Streptostachys*. The following five genera are variable for this character (*Cleistochloa*, *Coelachne*, *Isachne*, *Microcalamus* and *Thrasya*). Surface ornamentation of the upper floret occurs in 10 descriptions. The most common state is smooth which occurs in 56 genera. *Sacciolepis* and *Snowdenia* have a scabrous upper lemma. Striate taxa include *Hygrochloa*, *Tatianyx* and *Thyridolepis*. Eight taxa (eg. *Cleistochloa* and *Stereochlaena*) are exclusively muricate. A pitted upper lemma does not occur in the Paniceae. Possibly the most taxonomically significant character state is whether the upper lemma is rugose or not. The following eight genera are exclusively rugose (*Eriochloa*, *Holcolemma*, *Ixophorus*, *Paspalidium*, *Setaria*, *Setariopsis*, *Uranthoecium* and *Urochloa*). The remaining 24 genera are variable for this character. For example, *Digitaria* is smooth, striate or muricate but never rugose. Presence of basal modification in the form of scars, appendages or constrictions is used only in the diagnostic description of *Ichnanthus*; however, *Echinolaena* has similar modifications at the base. Presence of an awned upper lemma is used in 43 descriptions. Ninety-three of the genera are unawned. Awned upper florets occur exclusively in *Alloteropsis*, *Calyptochloa*, *Mildbraediochloa* and *Uranthoecium*. Genera variable for this character

include *Acritochaete*, *Chaetium*, *Eriochloa*, *Snowdenia* and *Urochloa*. Whether the apex of the upper palea is enclosed at the apex is used only in the diagnostic description of *Scutachne*, but also characteristic of *Brachiaria* and *Anthaenantiopsis*. The typical number of stamens for the genera is three. Two stamens is a characteristic of *Reimarochloa*, but may also be found in *Reynaudia* and *Coelachne*.

GENERIC SIMILARITIES

The objective of this section is to discuss morphological similarities among genera of the Paniceae as a mechanism of defining generic similaritites and generic concepts. To achieve this goal, it is advantageous to initially group together genera which have in common taxonomically significant characters. Once these initial groups are established the next most significant characters are used to define sub-groups or to isolate individual genera.

Whether the ultimate branches of the inflorescence terminates in a spikelet or bristle and point of disarticulation were the two characters shown to be most significant and reliable. These characters were initially used to separate among the genera. In the following lists of genera, numbers correspond to the generic numbers given with the diagnostic descriptions.

Cenchrus Group

15. *Cenchrus*
19. *Chamaeraphis*
20. *Chlorocalymma*
53. *Odontelytrum*
60. *Paractaenum*
62. *Paratheria*
65. *Pennisetum*
69. *Pseudochaetochloa*
70. *Pseudoraphis*
71. *Reimarochloa*
81. *Spinifex*
82. *Stenotaphrum*
84. *Streptolophus*
90. *Thuarea*
96. *Uranthoecium*
99. *Xerochloa*
102. *Zygochloa*

The *Cenchrus* group has in common the rachis terminating in a bristle and disarticulation at some point below the pedicel apex, usually at the base of the primary branches or at nodes of the main axis of the inflorescence. The most distinctive subgroup within this group are the Australia and Asia genera *Spinifex*, *Xerochloa* and *Zygochloa*. They have in common the inflorescences clustered in a spatheate raceme or panicle. *Spinifex* is unique in possessing a distinct bristle from 40 – 170 mm long, whereas the bristle in the other genera is much reduced. *Xerochloa* is the only genus with a spatheate raceme and thick spongy leaf blades. *Zygochloa* has an undeveloped callus and the upper floret lacks stamens. Of the remaining genera, *Chamaeraphis*, *Paractaenum*, *Reimarochloa*, *Stenotaphrum* and *Uranthoecium* have in common secund or distichous branching from the main axis

of the inflorescence. Within this subgroup *Chamaeraphis* and *Paractaenum*, both from Australia, possess a differentiated callus and are best separated on texture of the upper floret. Presence of an awned upper floret distinguishes *Uranthoecium*, also from Australia, from this subgroup as does a hyaline modification on the lower lemma. The North American genus, *Reimarochloa*, is unique in the complete absence of the second glume. *Stenotaphrum* lacks the characters used to define other genera within this subgroup.

No character or combination of characters make a reasonable separation of the remainder of this group into unique morphologically similar subgroups. *Pseudoraphis* occurs here and also in the *Setaria* group due to its variation in point of disarticulation. It is most similar to taxa of the *Setaria* group. However, here it is unique in the presence of a pronounced rachilla between the florets. *Cenchrus* and *Pennisetum* are morphologically similar and overlap on most of the taxonomically important characters. The only reliable character concerns modification of the callus. In *Cenchrus* the callus apex is flared to form a receptacle for the spikelets, whereas in *Pennisetum* the callus is not flared. *Chlorocalymma*, a monotypic from Africa, has a series of unusual characteristics. Primary branches are broadly winged and enclose the spikelets, bristles are flattened and branched, and the lower lemma is winged. *Odontelytrum*, another African monotypic, lacks these characters but has in common with *Chlorocalymma* adaxial spikelets. A second glume less than 0.1 times spikelet length is the best character for distinguishing *Paratheria*. *Pseudochaetochloa*, an Australian monotypic, is the only dioecious genus of this group. Unique modifications of the branches of the primary branch in the form of hardened recurved spines serves to distinguish *Streptolophus*, an African monotypic. *Thuarea*, a monotypic from Asia and Australia, is morphologically similar to *Stenotaphrum*, however, it has adaxial and andromonecious spikelets.

Setaria Group

26. *Dissochondrus*
33. *Holcolemma*
37. *Hygrochloa*
42. *Ixophorus*
52. *Neurachne*
61. *Paraneurachne*
63. *Paspalidium*
69. *Pseudochaetochloa*
70. *Pseudoraphis*
76. *Setaria*
77. *Setariopsis*
88. *Thrasya*
89. *Thrasyopsis*
92. *Thyridolepis*

The *Setaria* group consists of 14 genera and possesses in common a rachis terminating in a bristle and disarticulation at the spikelet base. The most recognizable subgroup within this group is comprised of the Australian genera *Thyridolepis*, *Neurachne* and *Paraneurachne*. In this subgroup the inflorescence is a

raceme and the ligule is a fringe of hairs. The first glume of *Thyridolepis* is unique within this subgroup and within the Paniceae in having a well-developed first glume with a transverse row of coarse seta subtended by a hyaline area. *Neurachne* has a smooth hyaline to membranous upper floret, whereas *Paraneurachne* has an indurate and muricate to rugose upper floret.

The remaining 11 genera of this group are best sub-divided into categories based on ornamentation of the lemma of the upper floret. *Dissochondrus*, *Holcolemma*, *Setaria*, *Hygrochloa*, *Setariopsis*, *Ixophorus* and *Paspalidium* have in common a rugose upper floret, whereas this structure in the remainder of the group is smooth to muricate. *Dissochondrus* in essentially identical to *Setaria* except for presence of more than one thickened fertile floret. The African genus *Holcolemma* is similar to *Paspalidium* and *Setaria* but has an inflated first glume and a central longitudinal groove on the lower lemma. *Hygrochloa* from Australia is the only monoecious genus of the group. The palea of the lower floret has pronounced wings in *Holcolemma* and *Ixophorus*. *Ixophorus* from Central America is best separated from *Holcolemma* on the basis of spreading primary inflorescence branches. *Paspalidium* is most similar to *Setaria* and distinguished on the basis of arrangement of the primary branches on the inflorescence. *Setaria* has quaquaversal primary inflorescence branches whereas *Paspalidium* has distichous or secund branching. *Pseudochaetochloa*, an Australian monotypic genus, is unique with andromonoecious sexuality. *Pseudoraphis* is the only member of this group with a pronounced rachilla between florets. *Setariopsis*, with two species from Central America, has a many-nerved second glume (13 – 23) and a hyaline area at the base of the lower lemma. *Thrasya* and *Thrasyopsis* are morphologically similar genera and the only members of this group with adaxial spikelets. These two genera are best separated on presence of a central groove on the lower lemma, number of nerves on the second glume, and texture of the lower floret.

Anthephora Group

8. *Anthephora*
9. *Arthragrostis*
14. *Calyptochloa*
18. *Chaetopoa*
86. *Tarigidia*
94. *Trachys*

The *Anthephora* group is characterized by the terminal inflorescence branches terminating in a spikelet and disarticulation at the base of the primary branches. There is no character or combination of characters which makes a reasonable separation of this group into unique morphologically similar subgroups. *Anthephora* has the first glumes modified into hardened bristle-like structures. In addition to this unusual character, it is best separated from other taxa with a pronounced callus and adaxial spikelets. Similar glume modifications are found in *Chaetopoa*, which is distinguished within this group by a relatively thin textured upper floret. First glume encircling the base of the spikelets separates

Arthragrostis, an Australian monotypic genus, from the other genera, as does the presence of a pronounced rachilla between the glumes. *Calyptochloa* is included in this group because of the secondary point of disarticulation at the culm nodes. It is most similar to the taxa of the *Melinis* group in which it shares the characteristic of primary point of disarticulation at the spikelet base. However, within this group *Calyptochloa* is best separated from the other genera on inflorescence form, type of ligule, presence of cleistogamous inflorescences, and other significant characters. *Tarigidia*, an African monotypic genus, is best separated on the presence of a differentiated callus and secund primary inflorescence branches. *Trachys* is unique in possessing a winged indurate lower lemma.

Isachne Group

22. *Coelachne*
32. *Heteranthoecia*
41. *Isachne*
45. *Limnopoa*
79. *Sphaerocaryum*

The *Isachne* group consists of those genera commonly placed in the Isachneae. This tribe is commonly defined on the basis of disarticulation above the glumes. However, this characteristic occurs within a number of genera of the Paniceae (see *Brachiaria*, *Panicum* and *Yakirra*). Point of disarticulation and differentiation of the pedicel apex is a combination of characters which separates this group. This complex of genera possesses in common persistent glumes after disarticulation and an undifferentiated pedicel apex. In the other members of the Paniceae where disarticulation occurs above the glumes the pedicel apex is consistently differentiated.

Within this group texture of the fertile floret and number of fertile florets are the best characters for distinguishing genera. *Coelachne* has two fertile florets and a membranous upper floret. *Heteranthoecia* has a hardened fertile floret, two florets, and a panicle with racemose primary branches. *Isachne* has hardened florets and a panicle with spreading primary branches. *Limnopoa* is unique in possessing a true raceme inflorescence. *Sphaerocaryum* has one fertile floret which is relatively thin in texture.

Digitaria Group

1. *Acritochaete*
5. *Ancistrachne*
6. *Anthaenantia*
10. *Arthropogon*
12. *Baptorhachis*
23. *Cyphochlaena*
25. *Digitaria*
38. *Hylebates*
39. *Hymenachne*
47. *Megaloprotachne*
50. *Microcalamus*
68. *Pseudechinolaena*
74. *Sacciolepis*
78. *Snowdenia*

34. *Homolepis*
35. *Homopholis*
83. *Stereochlaena*
91. *Thyridachne*

The *Digitaria* group consists of those genera in which the branches terminate in a spikelet, disarticulation at the spikelet base, flat margins on the upper lemma, and the ligule a membrane or ciliate membrane. Within this complex, texture of the upper floret is the best character for initially separating the 18 genera into subgroups. *Cyphochlaena* and *Arthropogon* are unique within this group in having a hyaline upper lemma. *Cyphochlaena* can also be distinguished on the presence of heteromorphic spikelets. On other characters, principally spikelet shape, *Cyphochlaena* is similar to *Cyrtococcum* a member of the *Panicum* group. *Arthropogon* is unique in having a differentiated callus. *Snowdenia* is the only member of this group with exclusively a membranous upper floret but can also be distinguished on the basis of a raceme inflorescence and present first glume.

A membranous to coriaceus upper lemma is characteristic of *Hylebates*, *Hymenachne*, *Acritochaete*, *Anthaenantia*, *Baptorhachis* and *Stereochlaena*. The best characters to separate *Hylebates* from other members of this subgroup include a pronounced rachilla between the glumes, an awned lower lemma, and spreading primary branches. The most similar genera to *Hylebates* is *Acritochaete* and *Baptorhachis*. *Hymenachne* is similar to *Digitaria* and *Homolepis* but can be separated on the presence of a rachilla pronounced between the glumes and first glume encircling the spikelet base. *Acritochaete*, an African monotypic, is similar to *Stereochlaena* and separated from the genera of the group by the presence of an awned second glume and lower lemma and oblique spikelets. *Anthaenantia* is similar to *Digitaria* and best separated within the group in lacking the first glume and having loosely arranged spikelets on the primary branches which are not distinctly secund. *Baptorhachis*, an African monotypic, is similar to *Acritochaete* but has a cleft and awned upper lemma and second glume. *Stereochlaena*, another African monotypic, also has an awned lower lemma but paired spikelets and lacks a main inflorescence axis.

Remaining genera of this group have a cartilaginous to indurate upper floret. *Megaloprotachne*, *Pseudechinolaena* and *Thyridachne* are similar with a grooved lower lemma. Within this subgroup *Megaloprotachne* is unique in having a first glume not encircling the spikelet base. *Pseudechinolaena* has a pronounced rachilla between the florets whereas *Thyridachne*, an African monotypic, lacks this development. *Sacciolepis* is unique in having a saccate second glume and *Ancistrachne* has unicinate hairs on the second glume. *Microcalamus*, an African monotypic, has a pronounced rachilla between the florets and a differentiated apex on an indurate upper lemma. *Digitaria*, *Homolepis* and *Homopholis* are morphologically similar. Within this subgroup *Homopholis* has margins of the upper lemma with the same texture as the body. *Digitaria* is best separated from *Homolepis* on the basis of spikelet orientation. *Digitaria* is abaxial.

Melinis Group

3. *Alloteropsis*
4. *Amphicarpum*
6. *Anthaenantia*
10. *Arthropogon*
14. *Calyptochloa*
17. *Chaetium*
21. *Cleistochloa*
44. *Lecomtella*
48. *Melinis*
49. *Mesosetum*
51. *Mildbraediochloa*
72. *Reynaudia*
73. *Rhynchelytrum*
75. *Scutachne*
93. *Triscenia*

The *Melinis* group consists of those taxa with the rachis terminating in a spikelet, disarticulation at spikelet base, upper lemma with flat margins, and the ligule a fringe of hairs. Included here are two genera, *Calyptochloa* and *Chaetium*, previously treated in the *Anthephora* group. *Anthaenantia* and *Arthropogon* also occurs in the *Digitaria* group but also need to be treated here. Within this generic complex the best character to separate among the genera is texture of the upper floret. Seven genera have an upper floret hyaline to membranous and 10 genera are chartaceous to indurate. Only two genera, *Lecomtella* and *Rhynchelytrum*, overlap the subgroups.

The upper lemma is hyaline to membranous in *Arthropogon*, *Lecomtella*, *Melinis*, *Mildbraediochloa*, *Reynaudia*, *Rhynchelytrum* and *Triscenia*. Within this subgroup of similar taxa, *Arthropogon* is best distinguished by the presence of a differentiated callus and an awned first glume. *Lecomtella* is the only andromonoecious genus of the subgroup but is also separated on the basis of differentiated upper lemma margins and an unawned first glume. *Mildbraediochloa*, an African monotypic, is unique within this group in having an awned upper floret. *Reynaudia* is the only genus consistently with two stamens but can also be separated on the basis of an undifferentiated callus and awned first glume. It is most similar to *Arthropogon*. *Melinis* and *Rhynchelytrum* are morphologically similar. They are similar in terms of the following significant sequence of characters which serve to separate them from other genera of this subgroup; plants hermaphroditic, inflorescence a panicle, primary branches spreading, first glume present, first glume muticous and upper lemma muticous. They are best separated on the basis of arrangement of the primary inflorescence branches. In *Rhynchelytrum* the primary branches are secund or distichous. It is interesting to note that all the genera of this subgroup have lateral compression of the spikelets except *Triscenia* which is dorsiventrally compressed.

The upper lemma is chartaceous to indurate in *Alloteropsis*, *Amphicarpum*, *Anthaenantia*, *Calyptochloa*, *Chaetium*, *Cleistochloa*, *Lecomtella*, *Mesosetum*, *Rhynchelytrum* and *Scutachne*. Two Australian genera *Calyptochloa* and *Cleistochloa* and the North American *Amphicarpum* possess cleistogamous inflorescences.

Within these three genera *Calyptochloa* is distinguished by an awned upper floret. *Amphicarpum* is best separated from *Cleistochloa* on the location and morphology of the cleistogamous spikelets. In *Amphicarpum* they are subterranean and morphologically different from the chasmogamous spikelets. *Alloteropsis* and *Chaetium* differ from the remaining taxa in the presence of an awned upper floret and best separated from each other due to the oblique spikelet base in *Chaetium*. Remaining genera of this subgroup include *Anthaenantia*, *Chaetium*, *Lecomtella*, *Mesosetum*, *Rhynchelytrum* and *Scutachne*. *Anthaenantia* is the only genus of this subgroup lacking a first glume. *Lecomtella* is the only andromonoecious genus and also the only C-3 genus. A raceme inflorescence is found exclusively in *Mesosetum*. *Chaetium*, in which the upper floret may be unawned, is unique in this last subgroup of six genera in having a flat pedicel apex. Unique significant characteristics of *Rhynchelytrum* within this subgroup include the presence of secund or distichous primary branches and loosely arranged spikelets. *Scutachne* is unique within this group with the first glume completely encircling the spikelet base.

Panicum Group

2. *Acroceras*
7. *Anthaenantiopsis*
9. *Arthragrostis*
11. *Axonopus*
16. *Centrochloa*
24. *Cyrtococcum*
29. *Echinolaena*
31. *Eriochloa*
33. *Holcolemma*
36. *Hydrothauma*
40. *Ichnanthus*
43. *Lasiacis*
46. *Louisiella*
4. *Oplismenopsis*
5. *Oplismenus*
57. *Otachyrium*
8. *Ottochloa*
9. *Panicum*
4. *Paspalum*
66. *Plagiantha*
67. *Poecilostachys*
80. *Spheneria*
88. *Thrasya*
89. *Thrasyopsis*

The *Panicum* group consists of genera having in common the branches terminating in a spikelet, disarticulation at spikelet base, upper lemma with involute margins, and the ligule a membrane or ciliate membrane. As in previous groups, INTKEY analysis indicated that texture of the upper floret is the best or most significant character to initially separate among the genera of the group. Eight genera possess a hyaline to chartaceous upper floret. These include *Anthaenantiopsis*, *Cyrtococcum*, *Hydrothauma*, *Louisiella*, *Oplismenopsis*, *Otachyrium*, *Plagiantha* and *Poecilostachys*. *Anthaenantiopsis* is the only member of this subgroup with a flat to convex pedicel apex. It is also the only member with the palea of the upper floret not enclosed at the apex. *Cyrtococcum* is unique with a crested differentiated apex on the upper lemma. In addition, it has lateral compression

of the spikelets and quaquaversal primary inflorescence branches. *Cyrtococcum* is similar to *Poecilostachys* which also has lateral spikelet compression. *Poecilostachys* differs from *Cyrtococcum* on the absence of a differentiated upper lemma apex. *Hydrothauma*, an aquatic monotypic genus from Africa, is the only member of this subgroup with abaxial spikelets. Leaf blades of *Hydrothauma* are unique within the Paniceae due to the development of sinuous longitudinal lamallae on the adaxial surface of the leaf blades. *Louisiella*, a monotypic genus from Africa, is the only member of this subgroup with a relatively short upper floret (0.5 – 0.6 times spikelet length). It can also be distinguished on the first glume encircling the spikelet base and growing in hydrophytic habitats. *Oplismenopsis*, a South American monotypic, also grows in water and the only member of this group with an awned second glume. *Otachyrium*, a South American genus of about seven species, also grows in wet habitats and has three characteristics of equal significance which are unique within this subgroup. It is the only member with a dense textured lower lemma, the nerves of the lower palea developed into lateral wings, and lower lemma hyaline in the central area. *Plagiantha*, another South American monotypic, is most similar to *Otachyrium* and best separated from this genus due to the presence of a differentiated apex on the upper lemma.

The second subgroup within the *Panicum* group consists of the remaining taxa and defined on the basis of a cartilaginous to indurate upper floret. Two genera, *Cyrtococcum* and *Otachyrium*, overlap between the subgroups. Within this second subgroup of nineteen genera the best separating character is whether the genera are C-3 or C-4.

C-4 genera include *Axonopus*, *Centrochloa*, *Eriochloa*, *Holcolemma*, *Panicum*, *Paspalum*, *Spheneria*, *Thrasya* and *Thrasyopsis*. The first glume fused with the callus to form a distinct cup-like structure is only found in *Eriochloa*. Partial fusion of the first glume is found in *Thrasya*. *Spheneria*, a South American monotypic, is the only genus with an oblique attachment of the pedicel and spikelet base. Once *Spheneria* is excluded, *Paspalum* becomes the only genus with abaxial spikelet orientation. *Axonopus* is most similar to *Thrasya* and best separated from members of this subgroup in lacking the first glume, adaxial spikelets, callus undifferentiated, and absence of the central groove on the lower lemma. *Centrochloa*, a South American monotypic, is very similar to *Axonopus* and differentiated on the presence of a short blunt callus and the extension of the second glume into a long point or spur. *Holcolemma* is included in this group due to its variation in the presence of absence of a bristle. Overall, it is most similar to members of the *Setaria* group. Here, it is separated on the basis of the rugose upper floret and the first glume not fused as in *Eriochloa*. *Paspalum* is best separated due to abaxial spikelets and a flat to convex pedicel apex. It is most similar to *Thrasya*. *Thrasya* and *Thrasyopsis* possess in common a hyaline area in the central part of the lower lemma. They are best separated from each other on the number of second glume

nerves and texture of the florets. *Panicum* is distinguished from these genera in lacking the characters or combination of characters used to define the other genera.

C-3 genera include *Acroceras, Arthragrostis, Cyrtococcum, Echinolaena,. Ichnanthus, Lasiacis, Oplismenopsis, Oplismenus, Otachyrium, Ottochloa* and *Panicum.* Within this subgroup *Acroceras, Arthragrostis, Echinolaena, Ichnanthus* and *Panicum* have the rachilla pronounced between florets. *Ichnanthus* and to a limited degree *Echinolaena* is unique in possessing pronounced basal scars or appendages associated with the rachilla and upper floret base. *Arthragrostis* has a relatively long and filiform rachilla. *Acroceras* is separated within this subgroup in having a differentiated apex of the upper lemma. *Echinolaena* is unique with the pedicel apex flat and not concave. *Panicum* lacks those characteristics used to define the other genera.

Genera lacking the pronounced rachilla between florets include *Acroceras, Cyrtococcum, Lasiacis, Oplismenopsis, Oplismenus, Otachyrium, Ottochloa* and *Panicum. Acroceras, Cyrtococcum, Lasiacis* are differentiated at the apex and separated on the basis on spikelet compression. *Lasiacis* has terete spikelets, *Cyrtococcum* laterally compressed spikelets, and *Acroceras* dorsiventrally compressed. An undifferentiated upper lemma apex and an awned first glume separates *Oplismenopsis* and *Oplismenus* which are distinguished on the first glume encircling the spikelet base in *Oplismenopsis. Otachyrium* is the only member of this subgroup with a hyaline area on the central part of the lower lemma. *Ottochloa* is the only member of this subgroup with abaxial spikelets but also has equal glumes shorter than the spikelet.

Paspalum Group

3. *Alloteropsis*
7. *Anthaenantiopsis*
11. *Axonopus*
13. *Brachiaria*
14. *Calyptochloa*
27. *Eccoptocarpha*
28. *Echinochloa*
29. *Echinolaena*
30. *Entolasia*
31. *Eriochloa*
40. *Ichnanthus*
56. *Oryzidium*
64. *Paspalum*
85. *Streptostachys*
87. *Tatianyx*
89. *Thrasyopsis*
95. *Tricholaena*
97. *Urochloa*
98. *Whiteochloa*
100. *Yakirra*
101. *Yvesia*

The *Paspalum* group is characterized by the rachis terminating in a spikelet, disarticulation at the spikelet base, margins of the upper lemma enrolled, and the ligule a fringe of hairs are absent. A number of these genera overlap with previously defined groups but are best discussed here to show the overall similarity within the tribe. There are no characters which make a suitable separation of these

21 genera into large subgroups. *Entolasia* and *Streptostachys* have a hairy upper floret and are best separated by the rachilla pronounced between the florets in *Streptostachys*. *Eriochloa* is unique with the fusion of the first glume and callus.

Seven of the remaining 18 genera have a pronounced rachilla between the florets. These include *Calyptochloa*, *Eccoptocarpha*, *Echinolaena*, *Ichnanthus*, *Oryzidium*, *Whiteochloa* and *Yakirra*. *Ichnanthus* and to a limited degree *Echinolaena* is unique in possessing pronounced basal scars or appendages associated with the rachilla and upper floret base. These genera are best distinguished by the rachilla being curved in *Ichnanthus*. *Whiteochloa* is the only member of this subgroup with lateral spikelet compression. Only *Calyptochloa* has an awned first glume. *Eccoptocarpha* best separates from other members of this subgroup on the basis of the saccate second glume. *Oryzidium* is unique in having an awned lower lemma. Finally, *Yakirra* is most similar to *Ichnanthus* but separates due to the swollen rachilla.

Of the remaining 11 genera only *Urochloa* has a rugose upper floret. Of the remaining 10 genera only *Alloteropsis* has an awned upper floret. Of the remaining 9 genera only *Tatianyx* and *Tricholaena* have spreading primary inflorescence branches and these are best separated by the oblique spikelet base in *Tatianyx*. *Tricholaena* is also similar to members of the *Melinis* group.

Remaining seven taxa are best separated on differentiation of the pedicel apex. *Anthaenantiopsis*, *Paspalum*, *Thrasyopsis* have a flat to convex pedicel apex. *Paspalum* is the only member of this group with abaxial spikelet orientation. *Thrasyopsis* best separates from *Anthaenantiopsis* on the basis of the coarse texture lower lemma. Of the remaining four genera only *Echinochloa* has a differentiated upper lemma. A first glume is present only in *Brachiaria*. *Axonopus* and *Yvesia* are best separated on the absence of the lower palea in *Axonopus*.

Information presented by this analysis groups similar genera on the basis of the best shared significant characteristics. *Axonopus* and *Yvesia* are the last genera treated from the initial group of 102 taxa. These genera have in common the following sequence of characters; the rachis terminating in a spikelet, disarticulation at spikelet base, margins of upper lemma enrolled, ligule a fringe of hairs, a glabrous upper floret, first glume not fused with callus, rachilla not pronounced between florets, upper floret not rugose, upper floret not awned, appressed secondary branches, a concave pedicel apex, upper lemma not differentiated at apex and the first glume absent.

ADDITIONAL SIGNIFICANT CHARACTERS

Characters used in the analysis of the previous two sections were selected on the basis of an assessment of character reliability and the variation among the genera. Thirty-nine characters are used and discussed in the section describing the distribution of characters in the diagnostic descriptions. These characters and many others are used in the analysis and discussion of similarities among the

genera. There are a number of additional potentially important characters not used in either section due to the presence of more significant characters or by the relatively low reliability initially assigned to the character. The objective of this section is to briefly discuss these characters and to describe the value of the characters within the tribe.

Twenty-four of the genera are exclusively annual and 43 are exclusively perennial. The remaining 35 genera are variable. This character is important only for separating genera with a low number of species. Specifically, the 67 genera which are either annual or perennial are monotypic or contain a very few number of species. Most of the variable genera possess a relatively large number of species. Whether the culm internodes are hollow, spongy or solid has limited value. Nine genera are exclusively solid, 12 are exclusively spongy, and 57 are hollow only. Presence of spongy internodes is correlated with the occurrence in aquatic or semi-aquatic habitats. Viscid internodes are exclusive to *Melinis* and two genera, *Lecomtella* and *Tarigidia* are exclusively glaucous. Twenty-six genera possess species with viscid or glaucous internodes. Leaves are exclusively distichous only in *Chamaeraphis*; however, distichous leaves can occur in eight genera (*Chamaeraphis*, *Isachne*, *Limnopoa*, *Paspalum*, *Pseudoraphis*, *Reimarochloa*, *Spinifex* and *Stenotaphrum*). Ovate leaf blades are exclusive in *Sphaerocaryum*. Most of the genera (94) have filiform to linear blades. Four genera (*Calyptochloa*, *Microcalamus*, *Plagiantha* and *Streptolophus*) have lanceolate blades.

Whether the inflorescence is enclosed in the leaf sheath has limited taxonomic value. The inflorescence of all species of *Spinifex* and *Thuarea* are totally enclosed in sheaths. Some species of *Axonopus*, *Pennisetum* and *Zygochloa* have completely enclosed inflorescences. Partially enclosed inflorescences occur in 32 genera but is exclusive in *Lecomtella*, *Louisiella* and *Odontelytrum*. Most of the genera (95) have species with fully exerted inflorescences. A distinctly wavy inflorescence main axis is characteristic of *Anthephora* and *Chamaeraphis*. Width of the primary inflorescence branch greater than 5 mm occurs in some species of *Chlorocalymma*, *Streptolophus*, *Thrasya* and *Thrasyopsis*. In the remaining genera the primary branch is less 5 mm wide. Bristles are distinctly flattened in all species of *Chlorocalymma* and *Uranthoecium*. Other genera with flattened bristles include *Cenchrus*, *Odontelytrum* and *Paractaenum*. Branched bristles occur in *Chlorocalymma*, *Odontelytrum*, *Paractaenum* and *Streptolophus*. Remaining bristle bearing genera possess unbranched bristles.

Whether the spikelets occur solitary or paired has limited value. Sixty-eight genera are exclusively solitary and eight genera have only species with paired spikelets. Remaining genera are variable or not applicable for this character. Length of the first glume has limited diagnostic value for the genera; however, it becomes important when used relative to the length of other structures. Of the 95 genera possessing a first glume, 62 genera have a first glume 0.1 to 0.7 times the length of the second glume. Thirty-five genera have a first glume more than

0.7 times the second glume. There is an overlap of one genus. Perhaps this is somewhat misleading since the length of the first glume awn (when present) is included in the results. The best separation for the relative length of the first glume and spikelet length is at 0.5. Sixty genera are in the range of 0.1 to 0.5 and 43 in the range of 0.6 to 1.0. The best separation for the relative length of the second glume and spikelet length is at 0.7 to 0.8. Thirty-five genera fall into the range of less than 0.8 and 74 genera fall in the range of 0.9 to 1.0.

Presence of obvious transverse nerves on the lemma of the lower floret is found in *Eccoptocarpha* and also found in some species of *Paspalidium* and *Urochloa*. Relative length of the upper and lower florets has limited diagnostic value. Eleven genera have some taxa in which the upper floret is less than 0.5 times spikelet length and 94 genera have taxa with the upper floret greater than 0.5 times spikelet length. Diagnostic value of whether the lemma of the floret is shiny or dull is frequently underestimated. A shiny upper lemma is found in all species of *Brachiaria*, *Dissochondrus*, *Eccoptocarpha*, *Echinolaena*, *Homopholis*, *Hydrothauma*, *Oplismenopsis*, *Oplismenus*, *Oryzidium*, *Otachyrium*, *Paratheria*, *Poecilostachys*, *Pseudechinolaena*, *Pseudoraphis*, *Sacciolepis*, *Tatianyx* and *Tricholaena*. Seventy-eight genera have species in which the upper lemma is always dull. An overlap of seven genera exists for this character. For the 49 genera in which the margins of the upper lemma are flat, 20 have a relatively thin margin and 23 a margin of the same texture as the body. There is an overlap of six genera for this character.

SUMMARY

This paper presents a detailed discussion of the significance and application of characters in defining the taxonomy of the recognized genera of the Paniceae. Retrieval of this information was possible due to the application of the DELTA system. Traditional approaches do not provide the types of conclusions discussed in the preceding text. It was found that 39 characters were required to provided diagnostic descriptions for the 102 genera. A diagnostic description was given for each genus. When the full range of variation within the tribe is considered, these are the characters which in reality delineate the genera. Selection of these characters was determined by the variation within the genus and by the variation among the rest of the genera. If for some reason the definition of a genus were to change, this change would effect the definition of other genera within the tribe. The number of characters required to distinguish individual genera varied from two to fourteen and was dependent on how variable the genus was on significant characters. It was proposed that the relative significance of a character could be determined by the number of times that a character was required in the diagnosis.

A detailed discussion is provided on the distribution of significant characters among the genera. These 39 characters include the following which are not listed in order of significance. Three general characters were plant sexuality, branching pattern of the vegetative axis, and ligule type. Eleven inflorescence characters

include the type, arrangement of primary branches, orientation of secondary branches, degree of reduction of branches, arrangement of branches, presence of bristles, differentiation of pedicel apex, shape of pedicel apex, angle of disarticulation of pedicel apex, depression of pedicel apex, and point of disarticulation. Presence of a cleistogamous inflorescence was important in a limited number of genera. Three general spikelet characters were presence of heteromorphic spikelets, orientation of spikelets, and spikelet compression. Five first glume characters include presence or absence, presence of a callus, whether encircling the base, whether the base is inflated, and presence of an awn. Development and shape of a rachilla were included. Two second glume characters include presence and shape. Number of fertile florets was found to be significant. Three lower floret characters include texture, presence of a central groove, and presence of a hyaline area. Six upper floret characters include texture, shape of the margins, presence of hairs, ornamentation, basal modifications, and presence of an awn.

Genera were grouped based on the presence of shared significant characters. Point of disarticulation and whether bristles were present or absent were found to be the most significant characters and were used to make the initial separation of the genera into groups. Similarities within the groups were discussed using the next most significant characters. Recognized groups include the *Cenchrus*, *Setaria*, *Anthephora*, *Isachne*, *Digitaria*, *Melinis*, *Panicum*, and *Paspalum*. This study together with phenetic and cladistic studies will provide the basis from which a classification of the tribe will be produced.

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BOOK REVIEWS

ANDREWS, J. 1992. **American Wildflower Florilegium.** (ISBN 0-929398-43-2, Hbk). University of North Texas Press, P.O. Box 13856, Denton, TX 76203 (Order: Univ. Distr., Drawer C, College Station, TX 77843). $50.00, 125 pp.

Book-of-the-Month Club, Dividend Division, has picked *American Wildflower Florilegium* as one of the spring choices for club members. Jean Andrews "has gathered fifty-two strikingly beautiful American wildflowers which she has paired with a treatise giving the common name, the scientific name, family, origin, range, description, bloom period, pollinators, habitat requirements, propagation, remarks and etymology, and references.

Illustrated and written with the cooperation of the National Wildflower Research Center and the Department of Botany at the University of Texas at Austin, the *Florilegium* also includes a Foreword by Ghillean T. Prance, director of the Royal Botanic Garden at Kew, England."

GAUTIN, D.G., D.J. FUTUYMA and F.C. JAMES (Eds.). 1992. **Annual review of Ecology and Systematics, Volume 23.** (ISSN 0066-4162) Annual Review Inc., 4139 El Camino Way, P.O. Box 10139, Palo Alto, CA 94303-0897 Hardbound $44.00 (U.S.A.) and $49.00 (elsewhere). 556 pp.

Volume 23 has 20 chapters, the first eight which center on a common theme, global change. Peter M. Vitousek introduces the section by noting these "papers deal with ecological causes and consequences of global environmental change, and on the methods by which these can be studied. Global studies are likely to be among the most important concerns of ecological research and teaching for some decades. This collection is designed to demonstrate that a very wide array of ecological research is crucial to the analysis of global change—and that both our basic work as ecologists and our contribution to the understanding of Earth as a system will be enhanced if we keep that relevance in mind."

The remaining 11 chapters deal with a variety of ecological and systematic issues ranging from Natural Hybridization as an Evolutionary Process to Definition and Evaluation of the Fitness of Behavioral and Developmental Programs.

STUBBENDIECK, J., S.L. HATCH and C.H. BUTTERFIELD. 1992. **North American Range Plants (4th ed.).** (ISBN 0-8032-4218-2). University of Nebraska Press, 327 Nebraska Hall, 901 N. 17th St., Lincoln, NE 68588-0520. $20.00 Paper. 493 pp.

The first edition of *North American Range Plants* appeared in 1981. Each subsequent edition has reflected changes in nomenclature and distributions refined. In addition to these changes, the fourth edition contains additional information on each of the species and a complete set of new, larger illustrations. Each illustration includes a map showing (shaded) the distribution. The 200 species were selected based on abundance, desirability, or noxious properties.

CAREX RHYNCHOPERIGYNIUM (CYPERACEAE), A NEW SPECIES FROM HIDALGO, MEXICO, AND A KEY TO SPECIES OF MEXICAN AND CENTRAL AMERICAN *HYMENOCHLAENAE*

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ABSTRACT

Carex rhynchoperigynium, a new species of section *Hymenochlaenae*, is described from the Nonoalco area of northeast Hidalgo, Mexico. It differs from its putative closest relatives (*C. conspecta*, *C. brunnipes*, and *C. ixtapalucensis*) in having: purple, basal, bladeless sheaths and purple lower leaf sheaths as opposed to brown; perigynia pale green turning brown with age, not green and neither red-dotted nor purple-mottled; and wider achenes. The new species was found locally frequent in the spray of a waterfall. An updated key to the species of Mexican and Central American *Hymenochlaenae* is included.

Carex section *Hymenochlaenae* (Drejer) L.H. Bailey includes 58 species worldwide, with about 30 species in North and Central America, and 28 additional species in Eurasia and adjacent North Africa, with one apparently endemic to East Africa (Reznicek 1986). In 1986, Reznicek treated 13 species that occur in Mexico and Central America and in 1990 described habitats for the *Hymenochlaenae* as moist montane forests, wet meadows, and stream banks at 1500 – 3700 m.

Carex rhynchoperigynium S.D. Jones & Reznicek, sp. nov. WATERFALL CAREX. (Fig. 1).

Plantae cespitosae; culmis fertilis 95 – 98 cm altis; vaginis basales purpureis, glabris. Folia 5 – 11, plerumque basales; laminis 19 – 46 cm longis, 3.2 – 7.1 mm latis; vaginae 3 – 15 cm longae, glabrae; ligulis 5 – 6 mm longis. Inflorescentiae 18 – 31 cm longae; spicis 5 – 7, 2 – 4 spicis terminalibus staminatis; spicis lateralibus pistillatis vel androgynis, pendulis antrorse scabris; bracteis infimis laminis 29 – 32.5 cm longis, 2.5 – 3.0 mm latis atque vaginis 3.4 – 4.3 cm longis. Perigynia 3.5 – 4.2 mm longa, 1.3 – 1.8 mm lata, trigona, plerumque dilute viridia demum brunnescentia, glabra, rostris laevibus, patentibus vel reflexis 0.9 – 1.4 mm longis.

SIDA 15(2): 215 – 221. 1992

FIG. 1. *Carex rhynchoperigynium*, drawn from *S. & G. Jones 5543* (MICH), holotype, A. Habit. B. Inflorescence. C. Sheath and Ligule. D. Pistillate scale. E. Perigynium, side view. F. Perigynium, front view. G. Perigynium, top view. H. Achene, front view. I. Achene, top view. J. Staminate scale. K. Anther. Bar equals 10 cm in A, 1 cm in B – C, and 1 mm in D – K.

Achenia 1.8 – 2.1 mm longa, 1.2 – 1.4 mm lata. Styli marcescentes; stigmata 3. Antherae 3, 1.8 – 2.1 longae.

Plants cespitose with fibrous light brown roots not densely felted with root hairs; fertile culms 95 – 98 cm tall, obscurely trigonous, smooth with 3 – 4 reddish-purple bladeless basal sheaths. Vegetative shoots 20 – 21 cm tall; leaves 4 – 7, similar to those of fertile culm; pseudoculms to 6 cm tall. Leaves 5 – 11 per fertile culm, mostly basal; (first 4 are 17 cm or less from the rootstock); blades 19 – 45 cm long, 3.2 – 7.1 mm wide, striate; adaxial surface white granular, papillose, midvein smooth or coarsely antrorsely scabrous; adaxial side of outer leaf sheath white septate; abaxial surface glabrous, the margins smooth or minutely antrorsely scabrous; widest leaves 5.0 – 7.1 mm wide; leaf sheaths 3 – 15 cm long, more or less tightly enveloping culms, basal leaf sheaths purple, outer band of sheaths pale green, glaucous, glabrous; inner band of sheaths glabrous, white with or without orange dots (if present, especially prevalent along margins), hyaline, striate; apex broadly, minutely, or slightly convex, not noticeably callosed or discolored with or without a cluster of many orange-brown dots just below, ligules white, membranous, 5 – 6 mm long (or as little as 1 mm long on lower leaves), elongated, lingulate shaped, with a 0.3 – 0.4 mm wide orange-brown or orange-brown dotted fringed band along outer margins. Inflorescences 18 – 31 cm long with the upper 5 – 6 spikes overlapping, the lowest 2 spikes 12.5 – 21 cm apart; spikes 5 – 7, the terminal 2 – 4 staminate, single at nodes, pendulous on antrorsely scabrous slender peduncles; lowermost spikes with peduncles 2.5 – 4.3 cm long, 0.3 – 0.4 mm wide, the uppermost lateral spikes with peduncles 0.7 – 3.5 cm long, and 0.3 – 0.4 mm wide; lowermost bracts with blades 29 – 32.5 cm long and 2.5 – 3.0 mm wide and sheaths 3.4 – 4.3 cm long, the uppermost bracts much reduced in width. Terminal spikes 0.7 – 4 cm long, 1.4 – 3.0 mm wide ca. 15 – 165-flowered. Lateral spikes wholly pistillate or androgynous. If androgynous, distal staminate portion 2.5 – 7.5 mm long, 0.7 – 1.9 mm wide, ca. 1 – 24-flowered and pistillate portion 3.5 – 4.2 cm long, 6.4 – 7.3 mm wide, ca. 70 – 100-flowered. Lower lateral spikes pistillate, 4.5 – 5.5 cm long, 3.5 – 7.5 mm wide, ca. 90 – 110-flowered. Pistillate scales glabrous, 2.6 – 3.0 mm long, 1.0 – 1.5 mm wide, narrowly ovate to broadly obovate, margins either gradually tapered into an attenuate tip or a short awn abruptly arising from the continuation of the midvein; if awned, then awn antrosely scabrous, to 0.6 mm long. Pistillate scales hyaline, diffusely brown especially near apex to a band of green 0.2 – 0.3 mm wide around midvein. Conspicous midvein and a faint lateral vein on each side. Staminate scales 3.2 – 5.0 mm long, 1.4 mm wide, narrowly oblong elliptic, acuminate to emarginate apically with a short mucro, hyaline to stramineous, diffuse with reddish brown (rust), 1-veined. Perigynia 3.5 – 4.2 mm long, 1.3 – 1.8 mm wide, trigonous with apically convex sides, mostly pale green turning brown with age, glabrous, 16 – 20-veined, 2 – 3 prominent. Perigynia and beaks patent to reflexed, fusiform,

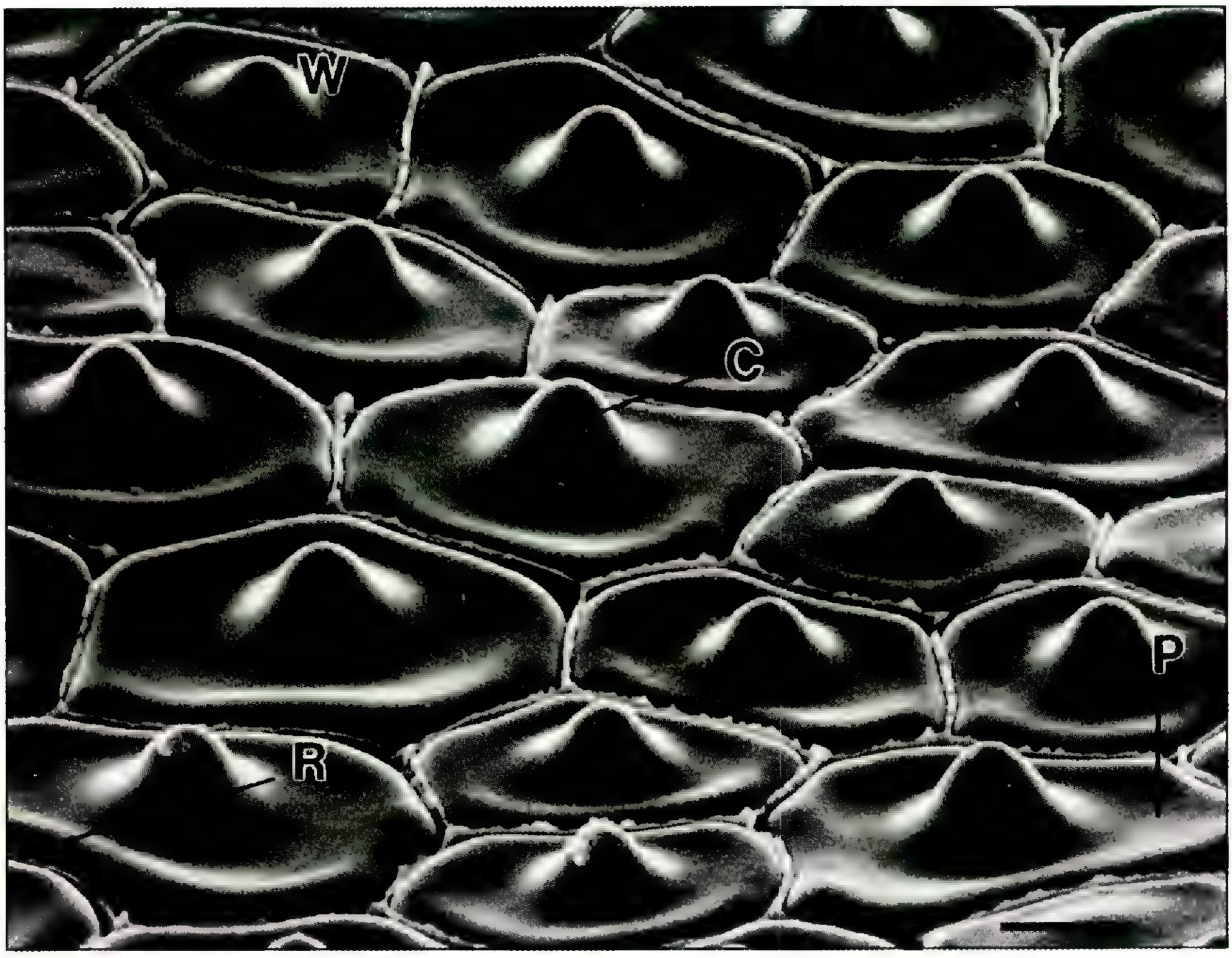

FIG. 2. *Carex rhynchoperigynium*, epidermal cells, SEM micrograph taken from *S. & G. Jones 5543* (Holotype: MICH). C. central body. P. silica platform. R. rim. W. anticlinal wall. Bar equals 10 µm.

more or less abruptly beaked. Beaks smooth, 0.9 – 1.4 mm long, bidentate; inside teeth antrorsely scabrous; teeth 0.3 mm long. Achenes 1.8 – 2.1 mm long, 1.2 – 1.4 mm wide, obliquely fusiform, trigonous, tightly enveloped by the perigynium, brown, pappilose, stipe up to 0.2 mm long; faces convex, at least apically, occasionally flat. Style withering, strongly contorted near base. Achene epidermal cells (fig. 2) non-isodiametric, single central body in each cell (± conical), with slightly raised rim around the edge of the slightly concave silica platform with or without a small silica satellite at the cell angles; anticlinal wall, appearing as mortar, separates each cell. Stigmas 3. Stamens 3, dark brown, anthers 1.8 – 2.1 mm long.

TYPE: MEXICO. HIDALGO. 47.5 km S on Mex 105 from its jct. with Mex 105 to Ontonga, ca. 1.4 km S of Nonoalco, 1950 m, 19 Jul 1990, *S. & G. Jones 5543 and E. Manrique* (HOLOTYPE: MICH; ISOTYPES: BRIT/SMU, MEXU, TAES).

Carex rhynchoperigynium was found growing on and at the base of an east-facing shale excarpment in the spray of a waterfall. Associated species include *Tibouchina* sp., *Equisetum* sp., *Bidens* sp., *Bouvardia* sp., *Lycopodium* sp., *Paspalum* sp., *Polypogon semiverticillatus* (Forssk.) Hyl., *Cyperus niger* Ruiz & Pavón, ferns, liverworts, and

mosses. The unusual habitat suggests the possibility that this species may be a very localized endemic. The following key for the Mexican and Central American *Hymenochlaenae* is modified from Reznicek (1986, 1990):

A KEY TO MEXICAN AND CENTRAL AMERICAN SPECIES OF *CAREX* SECTION *HYMENOCHLAENAE*

1. Lowermost spikes erect on stiff peduncles; all peduncles but the lowermost exserted less than 1 cm beyond sheaths ..... *C. austromexicana*
1. Lowermost spikes arching to pendulous on filiform, flexuous peduncles; lower and middle peduncles exserted more than 1 cm beyond sheaths, except in depauperate individuals.
   2. Perigynium body pubescent.
      3. Lower leaf sheaths hispidulous with red prickle-trichomes; uppermost 3–5 lateral spikes closely aggregated, peduncle of terminal spike 1.8–4.8 (-7) mm long; anthers 1.3–2.5 mm long. ..... *C. caeligena*
      3. Lower leaf sheaths glabrous; uppermost 3–5 lateral spikes not closely aggregated, peduncle of terminal spike 4–17 mm long; anthers 2.3–3.8 mm long.
         4. Pistillate and staminate scales pubescent abaxially, the margins ciliate; perigynium beak with a hyaline, flared, ciliate apex ..... *C. publigluma*
         4. Pistillate and staminate scales glabrous abaxially or scabrous on the midvein, the margins not ciliate; perigynium beak more or less bidentulate at apex ..... *C. mackenziana*
   2. Perigynium body glabrous.
      5. Lower leaf sheaths sparsely to densely hispidulous with red prickle trichomes.
         6. Apex of inner band of leaf sheaths shallowly concave, more or less thickened; lowermost bracts with blades 1.7–5 mm wide; peri-gynia 2.7–6.0 mm long.
            7. Pistillate scales reddish purple; anthers 2.4–3.2 mm long; perigynia 3.9–6.0 mm long, gradually tapered to apex ..... *C. chiapensis*
            7. Pistillate scales green to stramineous; anthers 1.5–1.8 mm long; perigynia 2.7–4.5(-4.8) mm long, abruptly contracted into a beak 0.6–1.4 mm long ..... *C. perlonga*
         6. Apex of inner band of leaf sheaths deeply concave or even "V" shaped, thin and very fragile; lowermost bracts with blades 1–1.9 mm wide; perigynia 2.8–3.7 mm long ..... *C. flexirostris*
      5. Lower leaf sheaths glabrous.
         8. Widest leaves 11–25.5 mm wide; pistillate scales with a scabrous awn 0.4–4.7 mm long; basal sheaths red.
            9. Ligules 7–29 mm long; pistillate scales with awns 0.4–1.8(-2.4) mm long; lower 5–8(-12) spikes compound with up to 7 secondary spikes ..... *C. steyermarkii*
            9. Ligules 1.5–4.0 mm long; pistillate scales with awns 1.1–4.7 mm long; lower 2–3 spikes sometimes compound, the secondary spikes solitary ..... *C. huehueteca*
         8. Widest leaves 2.3–10.5 mm wide; pistillate scales obtuse to acuminate, awnless or with an awn 0.3–1.5 mm long (in *C. pertenuis* and rarely in *C. caxinensis*); basal sheaths red or brown.

10. Terminal spikes androgynous or staminate proximally and distally and pistillate in middle; lower staminate scales acuminate to awned; basal bladeless sheaths and lower sheaths red to purple.
    11. Perigynia 3.9 – 6.0 mm long; widest leaves 6.5 – 7.0 mm wide ..... *C. chiapensis*
    11. Perigynia 2.6 – 3.8 mm long; widest leaves 2.3 – 4.6 mm wide.
        12. Staminate scales 3.2 – 4.5 mm long, usually scabrous-awned; anthers 1.6 – 2.2 mm long; leaves flat to plicate near apex ..... *C. pertenuis*
        12. Staminate scales 4.4 – 7.5 mm long, acuminate and smooth-margined; anthers 2.6 – 4.0 mm long; leaves channeled near apex ..... *C. caxinensis*
10. Terminal spikes staminate; lower staminate scales obtuse to acuminate to scales obtuse to acuminate to emarginate with a short mucro; basal bladeless sheaths and lower sheaths pale brown or brown (except for *C. rhynchoperigynium*, which are purple).
    13. Peduncles single at nodes.
        14. Perigynia not strongly red-dotted or purple mottled, outcurved with patent to reflexed beaks; bladeless basal sheaths and lower leaf sheaths reddish-purple ..... *C. rhynchoperigynium*
        14. Perigynia strongly red-dotted and also sometimes purple mottled, straight with ascending to spreading beaks; bladeless basal sheaths and lower leaf sheaths brown.
            15. Ligule 8.5 – 14.5 mm long ..... *C. conspecta*
            15. Ligule 1.9 – 6 (-7.5) mm long.
                16. Abaxial leaf surface smooth and green ..... *C. brunnipes*
                16. Abaxial leaf surface whitishpapillose ..... *C. ixtapalucensis*
    13. Peduncles 2 – 4 per node at middle of inflorescence ..... *C. tunimanensis*

DISCUSSION

Carex rhynchoperigynium shares narrow leaves, glabrous perigynia, purplish basal bladeless sheaths, and glabrous lower leaf sheaths with *C. chiapensis*, *C. pertenuis*, and *C. caxinensis*, but is removed from them by having terminal spikes staminate opposed to terminal spikes androgynous or staminate proximally and distally with pistillate in the middle. This feature aligns it with *C. brunnipes*, *C. conspecta*, *C. ixtapalucensis*, and *C. tunimanensis*, although, these all have brown bladeless sheaths and lower leaf sheaths. However, *C. tunimanensis* differs sharply from the above group in having 2 – 4 peduncles per node at middle nodes of the inflorescence while the others have only a single peduncle per node. In addition to the features noted in the key, *Carex rhynchoperigynium* differs from members of the *C. conspecta* complex by its wider achenes ca. 1.5 times as long as wide verses 2 – 2.5 times as long as wide; and convex or prolonged apex of the inner band (at least on the lower sheaths) rather than concave.

Carex rhynchoperigynium was found growing on and at the base of an east-facing shale escarpment in the spray of a waterfall, thus giving it the common name of "waterfall sedge". Its scientific name refers to its strongly beaked perigynia.

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BOOK REVIEWS

ALLEN, C.M. 1992. **Grasses of Louisiana, 2nd ed.** (ISBN 0-9633191-0-8). Cajun Prairie Habitat Preservation Society, P.O. Box 172, Eunice, LA 70535. $30.00 postpaid, hardcover. iv + 320 pp.

"This updated, hardcover version contains keys and descriptions to more than 380 grass taxa growing without cultivation in Louisiana. The documented distribution by parishes for each taxon is presented in a checklist. Almost all taxa are illustrated with more than 370 illustrations." For more information, contact Charles Allen, Department of Biology, Northeast Louisiana University, Monroe, LA 71209, (318)342-1814.

SPERRY, N. 1991. **Complete guide to Texas Gardening (Revised edition of: Neil Sperry's complete guide to Texas Gardening).** (ISBN 0-87833-799-7). Taylor Publishing Company, 1550 West Mockingbird Lane, Dallas, TX 75235. $34.95, hardcover, 388 pp, numerous black/white illustrations and color photographs.

Contents include: Introduction, The beginnings of gardening, Planning your landscape, Trees for Texas, Shrubs, Vines, Groundcovers, Texas lawns, Annuals, Perennials, Fruits and nuts, Vegetable gardening, Appendix, Index, and Botanical Illustrations (148 line drawings of tree and shrub foliage).

BELL, P.R. 1992. **Green plants–their origin and diversity.** Dioscorides Press/ Timber Press 9999 SW Wilshire, Portland, OR 97225. 315 pp.

This is an extensively revised edition of "Diversity of Green Plants" P.R. Bell and C.L.F. Woodcock (1983), and provides an impressively documented, near encyclopedic overview of plant morphology and diversity at both a macro- and micro-scale. There are numerous clearly labeled and informative illustrations, and overall documentation is extensive.

Geological data for each major taxonomic group are reviewed, and strong opinions are expressed on origins and inter-relationships of members of the plant Kingdom. These evolutionary opinions are both strengths and weaknesses of the book. While opinions are expressed and data are alluded to, the author's major conclusions are left unsupported (i.e., page 272 "Some have envisaged the angiosperms appearing in upland regions...as early as the late Paleozoic." A very important statement with no attributions or references!).

Bell's book is an excellent first look into problems of plant evolution as they relate to plant diversity. General goals of providing an overview of a highly complex field are met, however, serious students will find it mainly useful as a starting point for more interesting in-depth studies.—*Clair R. Ossian.*

TAXONOMIC STUDY OF *VENEGASIA* (ASTERACEAE: HELENIEAE)

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ABSTRACT

The genus *Venegasia* is treated taxonomically. A single species *V. carpesioides* is recognized. It is largely confined to chaparral type vegetation of southern California and northern Baja California, Mexico. A map showing its distribution is provided. Possible relationships of this well-marked, isolated, genus are discussed and it is concluded that, on morphological grounds, its closest relatives are *Jamesianthus* and *Arnicastrum*, small relictual genera of the southeastern U.S.A. and Mexico, respectively.

KEY WORDS: Asteraceae, *Venegasia*, *Arnicastrum*, *Jamesianthus*, Mexico

Venegasia carpesioides is an attractive suffruticose herb or subshrub 1 – 3 m high. It has large yellow heads with prominent rays and has received the common name Canyon Sunflower (Dale 1986, McAuley 1985) and Jesuit Sunflower (Beauchamp 1986). The species is seemingly confined to the chaparral vegetation of southern California and northern Baja California where it is reportedly common in places, especially following fires.

Venegasia was established as a monotypic genus by De Candolle in 1837 with his description of *V. carpesioides*. It is typified by material collected by David Douglas in southern California; specimens from this collection were sent to De Candolle by the Royal Botanic Gardens, London (KEW).

The generic name commemorates Padre M. Venegas, an early Jesuit scholar and missionary writer of Pueblo, Mexico (Dale 1986). While originally and correctly spelled *Venegasia* by De Candolle, some workers have adopted the spelling *Venegazia* (e.g., Rydberg 1914).

Rydberg (1914) placed *Parthenopsis maritima* in synonymy with *Venegasia carpesioides*, but proposed the new species, *V. deltoidea*, the latter said to be recognized by its deltoid leaves (vs. cordate) and supposedly longer peduncles (mostly ca. 10 mm long vs. ca. 5 mm). Forms with deltoid leaves occur throughout the range of *V. carpesioides*, and peduncle length likewise varies (mostly from 1 – 6 cm). Recent floristic workers have consistently recognized but a single species (e.g., Munz 1974; Wiggins 1980), as do we. Indeed, since its description, to our knowledge, no one has recognized *V. deltoidea* as distinct.

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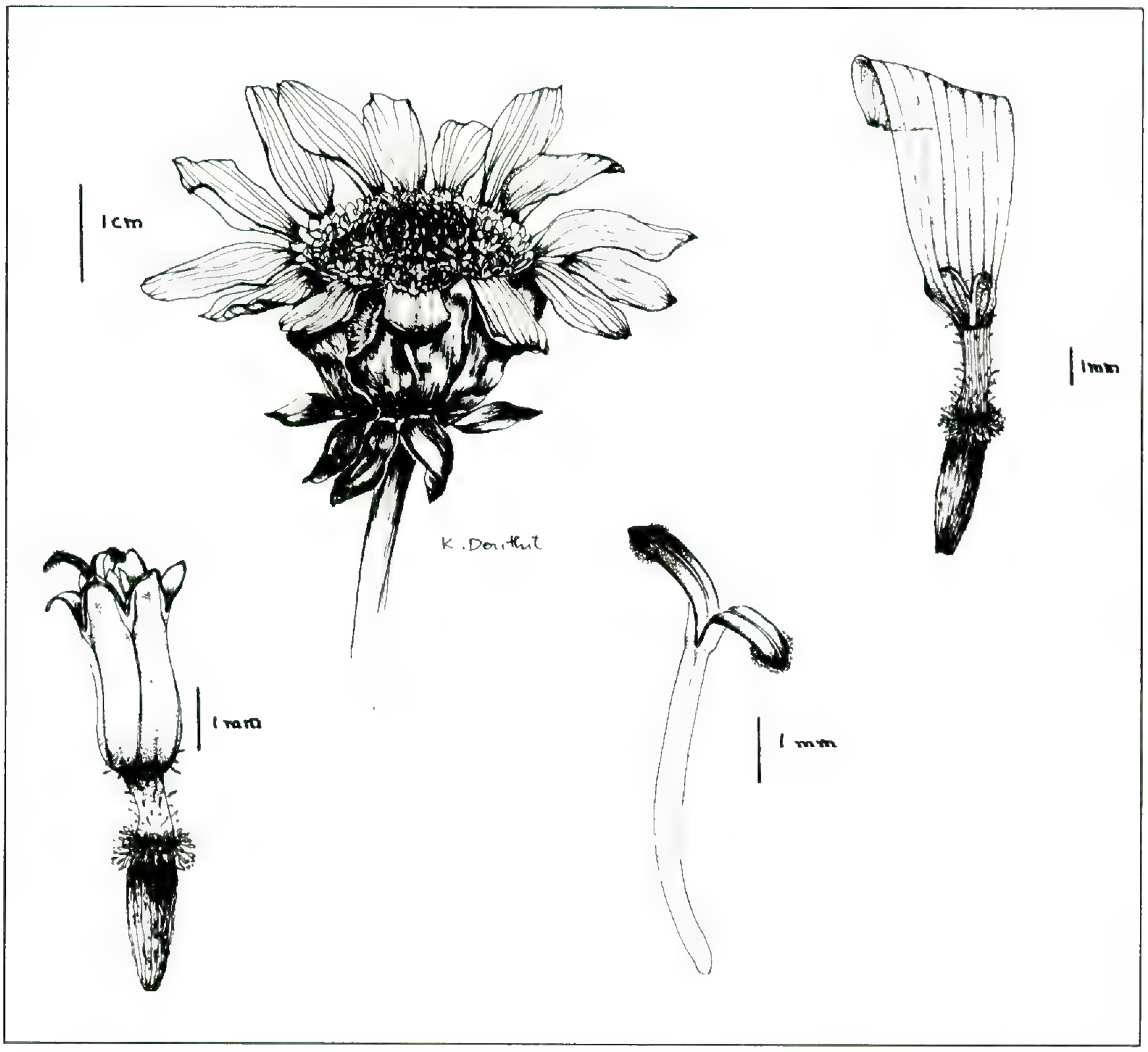

FIG. 1. Head and floral parts of *Venegasia carpesioides* (*Raven 15438*, TEX): upper left, head; upper right, ray floret; lower left, disk floret; lower right, style.

VENEGASIA DC., Prod. 6:43. 1837.

Parthenopsis Kellogg, Proc. Calif. Acad. 5: 100. 1873. Based on *Parthenopsis maritima* Kellogg

Suffruticose perennial herbs or shrublets 1 – 3 m high. Leaves mostly opposite, deltoid-ovate to cordate, markedly petiolate, glabrous or nearly so, the margins coarsely dentate to subentire. Heads hemispheric, mostly single and axillary, the peduncles 1 – 10 cm long. Involucres 3 – 4 seriate, the bracts subequal, the outer series mostly loose and subscarious, the middle series with broadly rounded apices. Receptacle convex, epaleate, minutely pubescent. Ray florets 13 – 34, pistillate, fertile, the ligules conspicuous, yellow. Disk florets numerous, yellow, the tube/limb ratio ca. 1/4, the tube densely glandular pubescent, 5-lobed. Anther appendages glandular. Appendages of style branches broadly obtuse in outline. Achenes clavate, black, striate, epappose. Base chromosome number, $x = 19$.

Type species, *Venegasia carpesioides* DC.

Venegasia carpesioides DC., Prod. 6: 43. 1837. TYPE: CALIFORNIA: w/o specific locality, 1833, *D. Douglas 54* (HOLOTYPE: P; ISOTYPE: NY!). The date and collection number are as given on the isotype.

Parthenopsis maritimus Kellogg, Proc. Calif. Acad. Sci. 5: 101. 1873. TYPE: CALIFORNIA: Santa Rosa Island, 1872-73, *W.G.W. Harford* (HOLOTYPE: CAS).

Venegasia deltoidea Rydb., N. Amer. Fl. 34, pt. 1: 5.1914. TYPE: MEXICO. BAJA CALIF. NORTE: "Sauzal", 7 Apr 1886, *C.R. Orcutt s.n.* (HOLOTYPE: NY!). As originally described, Rydberg gave the locality as "Sangal" but the locality on the type specimen appears to read as we give it here. El Sauzal is a fishing village located about 5 mi north of Ensenada, Mexico.

A single species, as described for the genus (cf. illustration, Figure 1 here and Figure 5319, Abrams & Ferris 1960).

Distribution and Ecology (Fig. 2): Coastal ranges of California from southern Monterey County to San Diego County and Channel Islands (Santa Rosa and Santa Cruz), southwards into Mexico along the coastal ranges to about latitude 31° N, occurring in coastal chaparral from near sea level to ca. 1000 m, reportedly common following burns. Flowering mainly from Apr-Jun.

GENERIC RELATIONSHIPS

When originally proposed, *Venegasia* was positioned in the tribe Senecionieae. Bentham (1873), largely because of its epaleate receptacles, placed the genus in the tribe Helenieae, subtribe Jaumeinae, where it was retained by Hoffmann (1894).

Turner and Powell (1976), in their sweeping conspectus of the tribe Helenieae, treated *Venegasia* rather indifferently, merely noting that it appeared to belong, along with *Jaumea*, in the subtribe Jaumeinae (which they positioned in their newly erected tribe Coreopsideae). They also noted that *Venegasia* and *Jaumea* seemed to have a number of morphological features which serve to relate the two genera to both the Coreopsideae and Senecioneae (e.g. *Arnica* and *Whitneya*). Stuessy (1976) accepted both *Jaumea* and *Venegasia* as the only members of his "group 7" of the subtribe Coreopsidinae of the Heliantheae.

Robinson (1981), in his account of the tribe Heliantheae (including Helenieae), in which 35 subtribes were recognized, daringly positioned *Venegasia* in the subtribe Chaenactidinae, which also included *Arnica* and *Whitneya* and numerous other rather anomalous genera (e.g. *Palafoxia*), but positioned *Jaumea* as a monotypic element of the subtribe Jaumeinae. Nevertheless, he singled out *Venegasia* as "singularly distinctive" among the subtribe Chaenactidinae in having stalked glands on its anthers.

Venegasia has a base chromosome number of $x = 19$ (Raven & Kyhos 1961; Keil & Pinkava 1976). Other isolated, seemingly relictual, genera of the Heliantheae such as *Jaumea*, *Montanoa*, and *Podachaenium*, share this meiotic count but these do not appear to relate closely to *Venegasia*. In contrast, within Robinson's concept of the Chaenactidinae there are several genera with base numbers of $x = 19$,

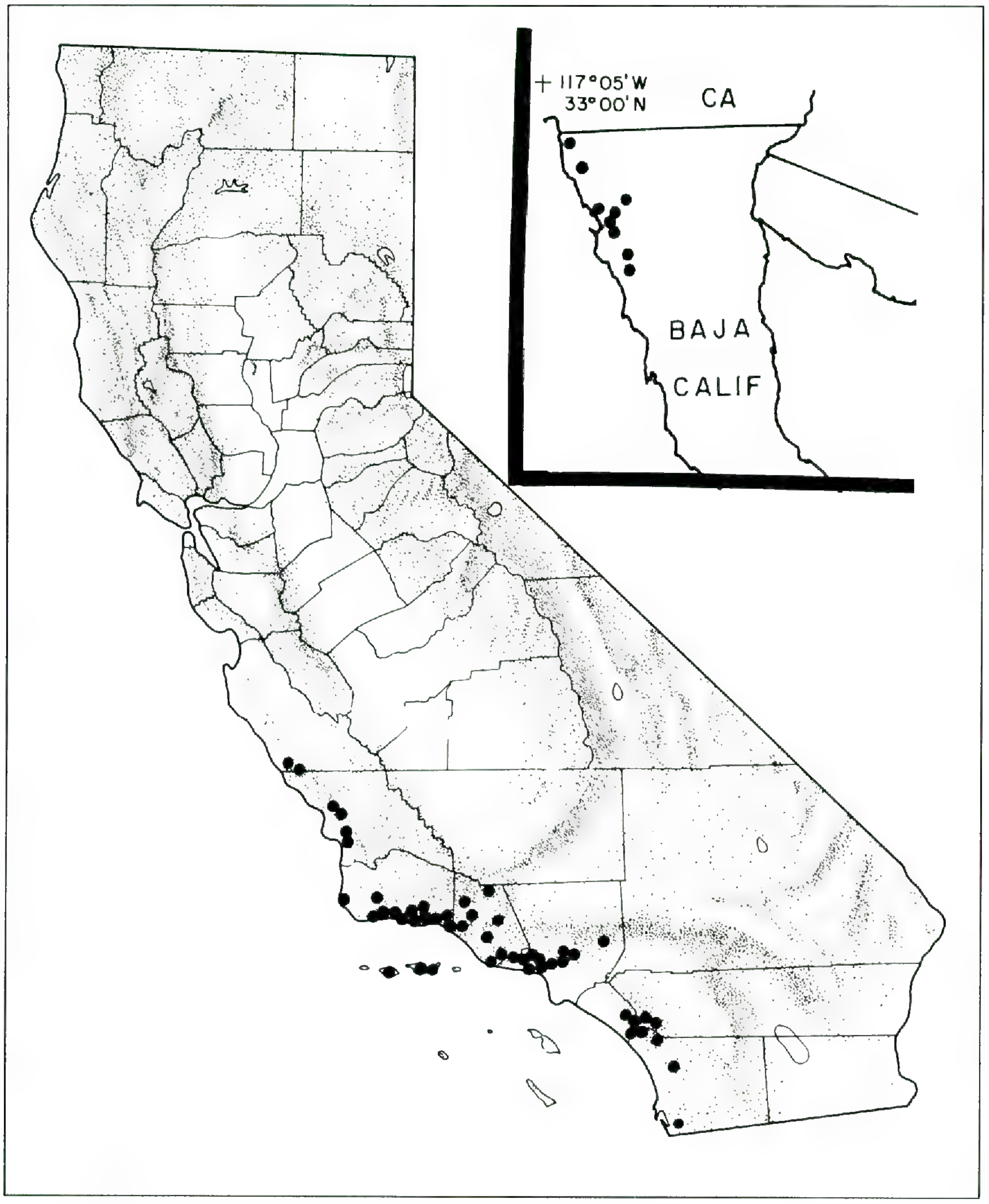

FIG. 2. Distribution of *Venegasia carpesioides* in U.S.A. (California) and Mexico (inset).

including *Arnica*, *Hulsea* and *Whitneya*, none of which, in our opinion, appears especially close to *Venegasia* on morphological grounds.

Limited phytochemical examinations of *Venegasia* by Crawford and Stuessy (1981) have shown that it does not possess anthochlors (chalcones and aurones), which would tend to exclude it from the tribe Coreopsideae, members of which tend to exhibit such compounds. Nonetheless, these authors retained *Venegasia* in that tribe, feeling that their absence in the latter was a loss phenomenon. Geissman and Atala (1971) noted the occurrence of the sesquiterpene lactone

TABLE 1. Comparison of genera whose relationships are thought to be closest to *Venegasia*.

Venegasia	*Arnicastrum*	*Jamesianthus*
Habit		
perennial herbs	perennial herb	perennial herb
stems suffruticose	herbaceous	herbaceous
Leaves		
alternate above	opposite	opposite
strongly petiolate	sessile	sessile or subsessile
Capitulescence (heads)		
mostly single	single	3 or more
axillary	terminal	terminal
Involucres		
bracts in 2 – 3 distinct series	ditto	ditto
subequal and subscarious	ditto	ditto
outer series loose and enlarged	ditto	ditto
Receptacles		
convex epalate	ditto	ditto
Ray Florets		
pistillate, fertile rays yellow	ditto	ditto
Disk Florets		
tube/limb ratio		
1/4	1/3 – 1/2	1/3
tube densely	sparsely	moderately
glandular pubescent	glandular pubescent	glandular pubescent
Anthers		
appendages		
glandular	glandular	glandular
Styles		
branches (apices)		
broadly conical	ditto	ditto
shaft nodular	ditto	ditto
at base		
Achenes		
ray florets		
epappose	pappose	epappose
disk florets		
epappose	10 bristles	∞bristles
black, striate	ditto	ditto
Chromosome No.		
x = 19	x = ?	x = 16

"eupatoriopicrin" in *Venegasia*, a compound previously reported only from the genera *Eriophyllum*, *Eupatorium* and *Chaenactis*. While the *Eupatorium* connection seems far-fetched, the *Eriophyllum* and *Chaenactis* connections are suggestive.

In summary, *Venegasia* does not appear to relate very closely to any known genera. After examining a large group of taxa, especially among the Helenieae, a tribe which the senior author now accepts as largely natural (Kim and Turner, in prep.), the genera he currently favors as closest to *Venegasia* on morphological grounds are *Arnicastrum* and *Jamesianthus*, both rare, presumably relictual genera which Robinson (1987) positioned in his subtribe Chaenactidinae. These several

taxa have a number of characters in common, as indicated in table 1. Whether these are properly positioned within Robinson's subtribe Chaenactidinae or better placed elsewhere must await more definitive studies, presumably using DNA data.

Representative Specimens: MEXICO. **Baja Calif. Del Norte**: 6 mi S of San Vicente, 11 Apr 1936, *Epling s.n.* (NY); 1 mi E of La Misión, 250 m, 30 Mar 1975, *Moran 21715* (ARIZ, POM, RSA, TEX, UC); canyon just E of Buena Vista, 230 m, 2 Jun 1979, *Moran 27542* (RSA); 5 km SE of Erendira, ca. 50 m, 7 Mar 1982, *Moran 29996* (ARIZ); 9 mi S of Maneadero, ca. 200 m, 21 Jun 1985, *Thorne 61047* (RSA); Rancho Loma Linda, Las Animas: N-facing slopes, ca. 200 m, 15 Mar 1987, *Thorne 62290* (RSA).

ACKNOWLEDGMENTS

This study is based upon the examination of approximately 205 sheets from the following herbaria (numbers in parenthesis refer to specimens loaned): ARIZ (8), JEPS (53), LL (7), POM (37), RSA (76), TEX (11), and UC (13). We are grateful to the Directors of these institutions for the loans concerned. Barney Lipscomb and an anonymous reviewer provided helpful suggestions on an earlier draft.

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BOOK REVIEWS

FREEMAN, C.C. and E.K. SCHOFIELD. 1991. **Roadside Wildflowers of the Southern Great Plains**. (ISBN 0-7006-0448-0). University Press of Kansas, 2501 West 15th Street, Lawrence, KS 66049-3904. Cloth $29.95, Paper $17.95. 280 pp + numerous color photographs and black and white illustrations.

A worthwhile field guide for any wildflower enthusiast whether professional or layman. It is laid out well by providing not only genus and species name but also family name and at least one vernacular name. Descriptions of plants are clear and understandable. Many fine line drawings by Ms. Schofield assist the reader with key identifying features. Habitat range and blooming period are included for each plant. Also, each plant covered has an exceptionally well done color plate showing the flowers, and many of them close up. However, the only weak point of the book is the lack of many of the color plates to show other equally important key identifying features of the plant such as leaves or overall growth habit.—*Jayne Uerling*.

FINLAYSON, M. and M. MOSER (Eds.) 1991. **Wetlands**. Facts of Life, Inc., 460 Park Avenue South, New York, NY 10016. Hbk $45.00. 224 pp.

The International Waterfowl and Wetlands Research Bureau (IWRB) present this text as a report on the status and value of wetlands around the world. Until recently the destruction of rain forests has received more press than wetland habitat destruction. Wetland destruction is happening down the street as well as foreign and exotic places. This volume explains what wetlands are and why they are valuable and why they are being destroyed and threatened. The Ramer Convention, 1971, is an intergovernmental treaty providing a framework for international cooperation for wetland conservation. Sixty countries have joined the Convention. The book list the countries and the habitats protected under the treaty and how much acreage. The text divides the world into Europe and the Mediterranean Basin; North America; Latin America and the Caribbean; Africa; Asia and the Middle East; and Australasia and Oceania. Each chapter reports on wetland habitats in that part of the world. Each section includes a continent map with the wetlands identified. A bird migration map is included. The text is enhanced with color photographs of wetlands, plants and animals. This book will interest conservationist, botanist, bird watchers and ecologist.—*Dotty Woodson*.

TETRANEURIS LINEARIFOLIA VAR. *ARENICOLA* (ASTERACEAE: HELIANTHEAE): A NEW VARIETY FROM SOUTH TEXAS

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ABSTRACT

Tetraneuris linearifolia var. *arenicola* var. nov. is described from South Texas, where it is endemic and restricted to habitats of sandy soil. Morphologic, cytologic, and chemical data are all consistent with its recognition as a variety of *T. linearifolia*.

RESUMEN

Se describe una nueva variedad endémica, *Tetraneuris linearifolia* var. *arenicola*, del sur de Tejas, restringida a los habitatas de sustrato arena. Datos morfológicos, citológicos y químicos son consistentes con reconocimiento de este taxón como una variedad de *T. linearifolia*.

INTRODUCTION

For several years the senior author has collected plants of the genus *Tetraneuris* E. Greene growing in deep sand in the vicinity of Brooks County in South Texas (Fig.1). It appeared that these plants were closely related to but distinct from plants classified as *Tetraneuris linearifolia*; however, caution was warranted until type studies could be done because *T. linearifolia* is morphologically very variable and several variants had already been described as species or varieties. Now that we have completed our type, morphologic, cytologic, and chemical studies, we are confident that this entity has not been described previously and that it should be recognized as a variety of *T. linearifolia*.

MATERIALS AND METHODS

For type studies, specimens were borrowed from BM, F, GH, K, MICH, MO, NDG, PH, RM, NY, UC, and US.

For morphologic studies, representative specimens from throughout the range of *Tetraneuris linearifolia* var. *arenicola* and var. *linearifolia* (Fig. 1) were examined

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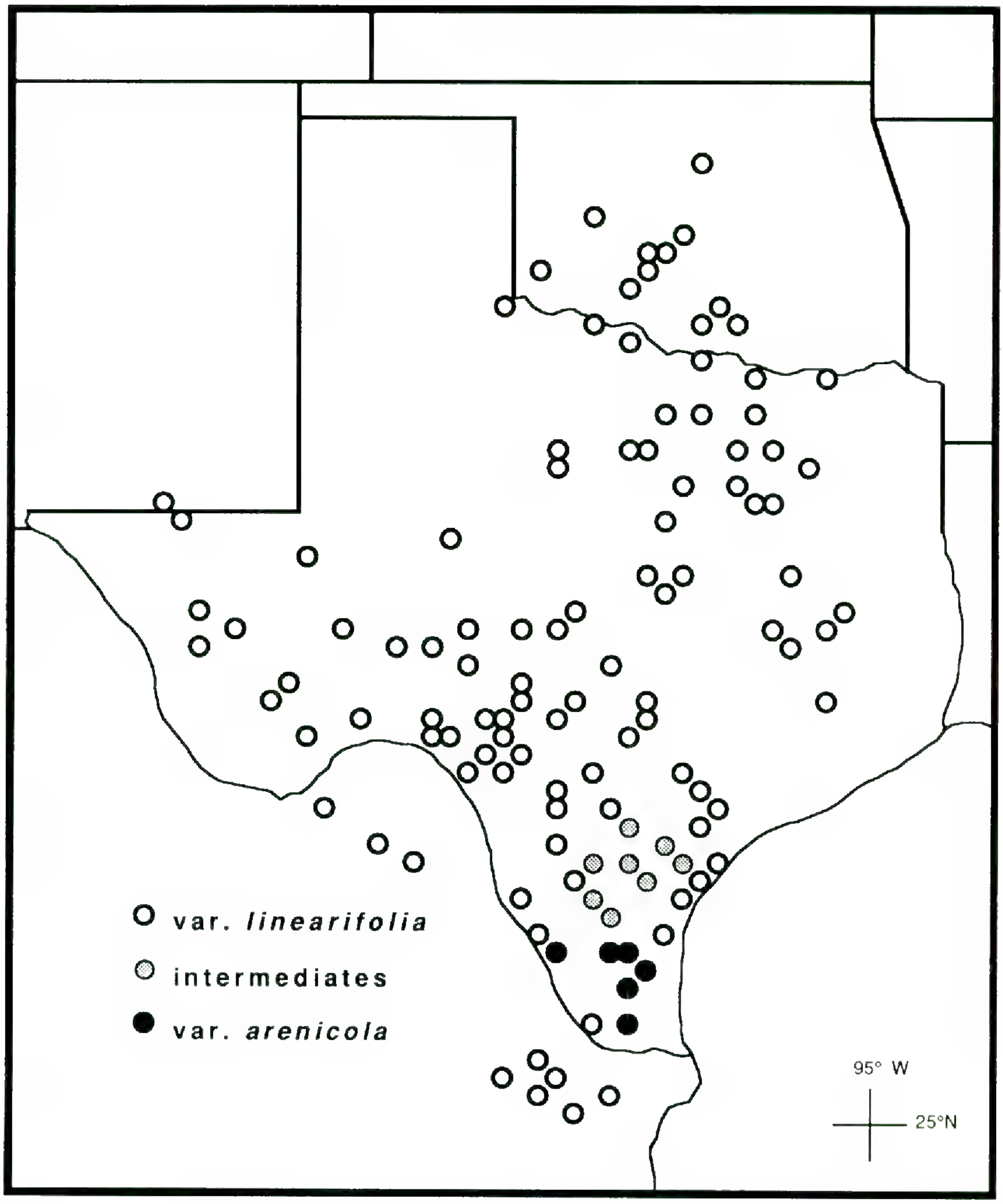

FIG. 1. Distribution of *Tetraneuris linearifolia* var. *linearifolia*, *T. linearifolia* var. *arenicola* and intermediates.

for descriptive purposes and for counts and measurements dealing with plant height, stem number, midstem leaf width, peduncle length, head number, height and diameter, and receptacle height and diameter. For counts and measurements dealing with outer and inner involucral bract number, length and width, ligule number, length and width, disc corolla length and diameter, disc corolla tube length, achene length and diameter, pappus scale number, length and width, and pappus scale awn length (when appropriate), ten specimens (from ten different populations of *T. linearifolia* var. *linearifolia* and from a total of four populations

of *T. linearifolia* var. *arenicola*) from throughout the range of each taxon were selected, and one flowering head was removed from each for examination. The heads were dissected after they had soaked in detergent water, and all parts except for the ligules were allowed to dry before any measurements were made. From each head, all of the involucral bracts and ligules were counted and measured, ten disc corollas were selected for measurements, ten achenes were selected for measurements and for pappus scale counts, and one pappus scale from each achene was selected for measurements. Counts and measurements are presented in the description as the mean plus or minus one standard deviation followed by the range (given as minimum to maximum) and sample size (n). Characters from the different taxa were compared using the unpaired, two-tail t-test (Table 1). Because we ran separate t-tests on multiple characters, we do not consider a difference to be statistically significant unless $p \leq 0.01$. All statistical work was done with StatView™ 512+ (Abacus Concepts, 1986) on a Macintosh II computer.

For cytologic studies, bud material was fixed in a modified Carnoy's solution: chloroform, absolute ethanol, and glacial acetic acid (4:3:1; V:V:V). Chromosomes were stained with acetocarmine, and counts were obtained from microsporocytes at diakinesis or metaphase I. Voucher specimens are deposited at SWT and TEX.

For chemical studies, we used 2 kg of aerial parts of *T. linearifolia* var. *arenicola* (*Bierner* 88-35, see list of specimens examined). Details of extraction, isolation, and identification are presented elsewhere (Díaz et al. 1992).

RESULTS AND DISCUSSION

In agreement with Parker (1980) and Robinson (1981), we are recognizing *Tetraneuris* E. Greene as a genus distinct from *Hymenoxys* Cass. Morphologically, both genera have two series of involucral bracts, but the outer and inner bracts are similar to one another and free in *Tetraneuris*, while the two series are dissimilar and the outer ones are united in *Hymenoxys*. In addition, all of the taxa placed in *Hymenoxys* sensu stricto have leafy stems and most have dissected leaves, while only four of 13 taxa in *Tetraneuris* have leafy stems, and none have dissected leaves. With regard to chemistry, taxa referable to *Hymenoxys* have a tendency to produce secohelenanolides in addition to other types of sesquiterpene lactones, while taxa referable to *Tetraneuris* have not yet been found to produce secohelenanolides (Seaman 1982). Conversely, acylated monoterpene glycopyranosides isolated from taxa referable to *Tetraneuris* (Gao et al. 1991; Zdero et al. 1991; Díaz et al. 1992) have not yet been isolated from taxa in *Hymenoxys*.

We examined all original descriptions and type specimens referable to *Tetraneuris*, and none of them matched the South Texas plants treated here as *Tetraneuris linearifolia* var. *arenicola*. Furthermore, it is our opinion that the names *Hymenoxys linearifolia* Hook. var. *linearifolia*, *Actinea ursina* Standley, *Actinella*

linearifolia (Hook.) Torrey & A. Gray var. *caule-elatiore* A. Gray, *Tetraneuris oblongifolia* E. Greene, *Tetraneuris linearifolia* (Hook.) E. Greene var. *latior* Cockerell, and *Tetraneuris linearifolia* (Hook.) E. Greene subsp. *dodgei* Cockerell should be treated as taxonomically synonymous.

Tetraneuris linearifolia var. *arenicola* differs from var. *linearifolia* in many of its characters (Table 1). Most notably, the two varieties differ with regard to the number of stems originating from the base of the plant, degree of stem and leaf pubescence, degree of leaf margin dentition, receptacle shape, degree of inner bract pubescence, and soil preference, and they are statistically significantly different from one another in plant height, midstem leaf width, peduncle length, head height and diameter, receptacle height and diameter, outer bract number, length and width, inner bract length and width, ray floret number, ligule length, disc corolla length and diameter, disc corolla tube length, achene length, pappus scale number and length, and pappus awn length (var. *arenicola* lacks awns). Of these, the most useful characters for diagnostic purposes are stem and leaf pubescence, leaf margin dentition, midstem leaf width, peduncle length, outer bract number, pappus scale number, presence or absence of the pappus awn, and soil preference.

Conversely, var. *arenicola* and var. *linearifolia* are very similar or identical with regard to habit, stem branching pattern, pattern of leaf attachment, number of heads per plant, head shape, involucral bract shape (both outer and inner), outer bract pubescence, inner bract number, ligule pubescence and width, disc corolla pubescence, achene characters other than length, and pappus scale shape and width (Table 1). Of particular note, they are the only two annual taxa in *Tetraneuris*, and only three other taxa in *Tetraneuris* have leafy stems. In addition, we have collected and seen herbarium sheets of difficult-to-classify plants from Duval, McMullen, Live Oak, and Bee counties (Fig. 1; Table 2). These plants tend to have stem and leaf pubescence similar to that of var. *arenicola*, midstem leaf width and leaf margin dentition that are intermediate, and awned pappus scales similar to those of var. *linearifolia*. Like var. *arenicola*, they tend to grow in sandy soil, but they have also been collected on limestone-derived soil, the preferred substrate of var. *linearifolia*.

Tetraneuris linearifolia var. *linearifolia* has been reported to have chromosome numbers of $n = 14$ (Turner & Flyr 1966; Urbatsch 1974; Strother 1983), $n = 15$ (Speese & Baldwin 1952; Powell & Turner 1963; Strother 1966), and $n = 15 + 1_b$ (Harms 1969). This taxon may indeed be dibasic, but it is notable that one herbarium sheet at TEX (Mexico, Nuevo Leon, *Turner & Powell 1066*) is annotated as "$n = 14_{II}$ (possibly 13_{II} + a ring of 4)". It is possible that a reciprocal translocation is present in some populations, and plants that are actually $2n = 13_{II} + 1_{IV}$ have been mistaken for $2n = 14_{II}$. *Tetraneuris linearifolia* var. *arenicola* is here reported to have $2n = 15_{II}$ (*Bierner 88-35* and *Bierner 91-12*, see list of specimens examined). In addition, some of the difficult-to-classify plants mentioned in the

TABLE 1. Morphologic comparison of *Tetraneuris linearifolia* var. *linearifolia* and *T. linearifolia* var. *arenicola*. For characters compared by *t*-test, the unpaired *t* value (*t*) and two-tail probability (*p*) are shown following the character. Counts and measurements are presented as the mean plus or minus one standard deviation followed by the sample size (*n*).

Character	*T. l.* var. *linearifolia*	*T. l.* var. *arenicola*
Habit	annual	annual
Plant height (t=3.96; p=0.0002)	2.6 ±0.6 dm (n=38)	3.4 ±0.7 dm (n=12)
Number of stems from the base	usually 1, sometimes 2 – 6	sometimes 1, usually 4 – 10
Stem branching pattern	corymbose	unbranched to corymbose
Stem pubescence	sparse to dense	dense
Stems leafy	yes	yes
Leaf pubescence	sparse to moderate	moderate to usually dense
Leaf margins (basal and lower leaves)	usually entire	usually 2 – 6-toothed or -lobed
Leaf margins (middle and upper leaves)	usually entire	often 1 – 2-toothed or -lobed
Midstem leaf width (t=9.46; p=0.0001)	2.2 ±0.8 mm (n=38)	6.7 ±2.8 mm (n=36)
Peduncle apex pubescence	usually dense	very dense
Peduncle length (t=6.99; p=0.0001)	11.8 ±2.6 cm (n=38)	17.8 ±4.6 cm (n=36)
Head number (t=-0.86; p=0.39)	29 ±19 per plant (n=38)	23 ±16 per plant (n=12)
Head shape	hemispheric	hemispheric
Head height (t=8.73; p=0.0001)	6.9 ±0.9 mm (n=38)	9.0 ±1.0 mm (n=27)
Head diameter (t=11.17; p=0.0001)	9.5 ±1.5 mm (n=38)	13.4 ±1.2 mm (n=27)
Receptacle shape	usually conic	hemispheric to occasionally conic
Receptacle height (t=3.23; p=0.002)	2.5 ±0.7 mm (n=38)	3.1 ±0.6 mm (n=26)
Receptacle diameter (t=7.18; p=0.0001)	2.9 ±0.8 mm (n=38)	4.4 ±0.9 mm (n=26)
Outer bract number (t=5.06; p=0.0001)	10 ±2 per head (n=10)	17 ±3 per head (n=10)
Outer bract shape	obovate to oblanceolate	usually oblanceolate
Outer bract outer surface pubescence	moderate to dense	dense
Outer bract length (t=11.81; p=0.0001)	3.7 ± 0.5 mm (n=104)	4.4 ±0.5 mm (n=165)
Outer bract width (t=-0.960; p=0.0001)	1.1 ±0.2 mm (n=104)	0.9 ±0.2 mm (n=165)
Inner bract number (t=2.22; p=0.0393)	17 ±6 (n=10)	22 ±4 (n=10)
Inner bract shape	obovate	obovate
Inner bract outer surface pubescence	moderate	dense
Inner bract length (t=9.71; p=0.0001)	3.3 ±0.4 mm (n=172)	3.8 ±0.5 mm (n=218)
Inner bract width (t=-4.64; p=0.0001)	1.2 ±0.2 mm (n=172)	1.1 ±0.2 mm (n=218)
Ray floret number (t=3.24; p=0.0045)	14 ±4 (n=10)	20 ±4 (n=10)
Ligule upper surface pubescence	glabrous	glabrous
Ligule lower surface pubescence	sparse to moderate	sparse to moderate
Ligule length (t=8.73; p=0.0001)	10.6 ±1.5 mm (n=137)	12.4 ±2.0 mm (n=187)
Ligule width (t=0.663; p=0.5077)	4.5 ±0.4 mm (n=138)	4.5 ±1.0 mm (n=187)
Disc corolla lobe pubescence	sparse to moderate	sparse to moderate
Disc corolla length (t=10.78; p=0.0001)	2.1 ±0.3 mm (n=100)	2.5 ±0.3 mm (n=100)
Disc corolla diameter (t=4.89; p=0.0001)	0.71 ±0.1 mm (n=100)	0.65 ±0.1 mm (n=100)
Disc corolla tube length (t=4.13; p=0.0001)	0.4 ±0.1 mm (n=100)	0.5 ±0.1 mm (n=100)
Achene shape	obconic to narrowly obconic	obconic to narrowly obconic
Achene pubescence	moderate to dense	moderate to dense
Achene surface	silver-white to brown	silver-white
Achene length (t=11.87; p=0.0001)	1.9 ±0.2 mm (n=100)	2.2 ±0.2 mm (n=100)
Achene diameter (t=-1.33; p=0.184)	0.7 ±0.1 mm (n=100)	0.7 ±0.1 mm (n=100)
Pappus scale number (t=17.06; p=0.0001)	5 ±1 per achene (n=100)	7 ±1 per achene (n=100)
Pappus scale shape	obovate	obovate
Pappus scale length (t=-9.35; p=0.0001)	1.6 ±0.3 mm (n=100)	1.3 ±0.1 (n=100)
Pappus scale width (t=0.321; p=0.7486)	0.7 ±0.1 mm (n=100)	0.7 ±0.1 mm (n=100)
Pappus awn length (t=-33.48; p=0.0001)	0.6 ±0.2 mm (n=100)	0 ±0 (n=100)
Soil preference	limestone-derived	sand

TABLE 2. Localities of specimens intermediate between *Tetraneuris linearifolia* var. *linearifolia* and *T. linearifolia* var. *arenicola*.

Bee Co.: below Skidmore on Sinton hwy, 3 Dec 1948, *Tharp et al. 48-99* (TEX).
Bee Co.: 1 mi S of Normanna, along Medio Creek, 28 Mar 1948, *Cory 54100* (LL).
Duval Co.: hwy 1329, 8.3 mi S of hwy 359 (jct in San Diego), 20 Mar 1991, *Bierner 91-10* (SWT, TEX). Chromosome number n – 15? Multivalents and lagging chromosomes noted.
Duval Co.: hwy 1329, 11.4 mi S of hwy 359 (jct in San Diego), 20 Mar 1991, *Bierner 91-11* (SWT, TEX). Chromosome number $2n = 15_{II}$. Lagging chromosome noted in one anaphase I cell.
Duval Co.: hwy 16, 5.1 mi N of hwy 44 (jct in Freer), 21 Mar 1991, *Bierner 91-16* (SWT, TEX).
Live Oak Co.: ca 4.5 mi N of Swinney Switch, 28 Mar 1963, *Correll 27036* (LL).
Live Oak Co.: 41 mi N of Alice, 1 Mar 1944, *Painter & Barkley 14463* (LL).
Live Oak Co.: hwy 59, 1.6 mi E of hwy 281, 24 Mar 1976, *Bierner 51518* (SWT, TEX).
Live Oak Co.: hwy 281, 2.8 mi S of hwy 59 (jct in George West), 19 Mar 1991, *Bierner 91-4* (SWT, TEX). Chromosome number $2n = 15_{II}$.
Live Oak Co.: hwy 281, 10.8 mi N of hwy 3162 (jct S of George West), 19 Mar 1991, *Bierner 91-5* (SWT, TEX).
Live Oak Co.: hwy 3162, 10.1 mi E of hwy 281, 19 Mar 1991, *Bierner 91-8* (SWT, TEX). Chromosome number $2n = 15_{II}$.
McMullen Co.: hwy 16, 3.6 mi N of hwy 624 (jct in south-central part of county), 21 Mar 1991, *Bierner 91-17* (SWT, TEX).

previous paragraph were examined for chromosome number and were found to have $2n = 15_{II}$. However, *Bierner 91-10* could not be counted due to the presence of multivalents and lagging chromosomes, and *Bierner 91-11* had one anaphase I cell with a lagging chromosome (Table 2).

Chemical studies of *Tetraneuris linearifolia* var. *arenicola* resulted in the isolation of five known helenanolides, two known germacranolides, a new guaianolide, ten new esterified glucopyranosides of 9-hydroxy-γ-geraniol, two new palmitates of lupeol derivatives, a mixture of glucopyranoside *p*-coumarates, and eight flavonoids including the new 6,8,3'-trimethoxy-5,7,4',5'-tetrahydroxyflavone; details of their isolation and identification are reported elsewhere (Díaz et al.1992). The chemistry of var. *arenicola* is very similar to that of var. *linearifolia* (Herz et al. 1970; Dominguez et al. 1980; Zdero et al. 1991). Three of the helenanolides, one of the germacranolides, two of the glucopyranoside *p*-coumarates, and one of the flavonoids isolated from var. *arenicola* have also been reported from var. *linearifolia* (Herz et al. 1970; Zdero et al. 1991). We isolated several compounds from var. *arenicola* that have not been reported from var. *linearifolia*, however, and several compounds reported from var. *linearifolia* (e.g., linearifolin B) were not isolated by us from var. *arenicola*. The ten new γ-geraniol glucopyranosides isolated from var. *arenicola* are similar to but not identical with a series of γ-geraniol glucopyranosides isolated from var. *linearifolia* (Zdero et al. 1991).

These taxa are here recognized as distinct because 1) they have separate geographic ranges, 2) they grow on different soils, and 3) they are morphologi-

cally distinct within their ranges. They are here treated as varieties of a single species because 1) they are morphologically very similar in many of their characters, and 2) there is a zone of intergradation in which the plants are difficult to identify as one variety or the other. The cytologic data (i.e., normal meiosis in plants that are morphologically distinct, but meiotic irregularities in some of the plants with intermediate morphology) and overall chemistry (i.e., the high degree of chemical similarity on the one hand along with differences [albeit minor] in sesquiterpene lactone and γ-geraniol glucopyranoside composition on the other) are consistent with the treatment of these taxa as conspecific but distinct at the varietal level.

TAXONOMY

Tetraneuris linearifolia (Hook.) E. Greene var. **arenicola** Bierner, var. nov.

Tetraneuris linearifoliae (Hook.) E. Greene var. *linearifoliae* similis sed foliis latioribus pubescentioribusque, foliis inferis saepe dentatis dentibus 2 – 6, caulibus pubescentioribus, et pappi squamis muticis differt.

Plants annual, 3.4 ±0.7 dm tall (range 2.2 – 4.8 dm; n = 12) excluding the root. Stems 1 to usually several (4 – 10), unbranched to sparingly branched to corymbosely branched above, sulcate below becoming striate above, densely pubescent throughout. Leaves moderately to, usually, densely pubescent, sparsely to moderately dotted with impressed glands and sometimes with sessile glands, midstem leaves 6.7 ±2.8 mm wide (range 2.5 – 16.0 mm; n = 36); basal leaves in a rosette, usually spatulate in outline, entire or, usually, with 2 to 6 lateral teeth or lobes, moderately to densely pubescent; lower leaves usually oblanceolate in outline, entire or, usually, with 2 lateral teeth or lobes or, occasionally, with 4 or 6 lateral teeth or lobes, moderately to, usually, densely pubescent; middle leaves usually oblanceolate in outline, entire or, often, with 2 lateral teeth or lobes, usually densely pubescent; upper leaves usually narrowly oblanceolate, usually entire but sometimes with 1 or 2 lateral teeth or lobes, usually densely pubescent. Peduncles 17.8 ±4.6 cm long (range 10 – 29 cm; n = 36), striate, expanded apically, moderately to densely pubescent below becoming very densely pubescent above, sparsely dotted with sessile glands. Heads 23 ±16 per plant (range 8 – 50; n = 12), hemispheric, 9.0 ±1.0 mm high (range 8 – 10 mm; n = 27), 13.4 ±1.2 mm in diameter (range 12 – 15 mm; n = 27) excluding the rays. Receptacles usually hemispheric to occasionally conic, naked, 3.1 ±0.6 mm high (range 2.0 – 4.6 mm; n = 26), 4.4 ±0.9 mm in diameter (range 3.0 – 6.0 mm; n = 26). Involucral bracts in two morphologically similar series; outer bracts usually 17 ±3 per head (range 13 – 21; n = 10), free, green and herbaceous, usually oblanceolate, apex obtuse to acute, outer surface and margins densely pubescent and eglandular to sparsely dotted with sessile glands, inner surface glabrous and eglandular, 4.4 ±0.5 mm long (range 3.0 – 5.5 mm; n = 165), 0.9 ±0.2 mm wide

(range 0.5 – 1.4 mm; *n*=165); inner bracts usually 22 ±4 per head (range 12 – 25; *n*=10), free, green and herbaceous with a hyaline margin, obovate, apex rounded to obtuse to acute, outer surface densely pubescent and eglandular to sparsely dotted with sessile glands, inner surface glabrous and eglandular, 3.8 ±0.5 mm long (range 2.7 – 4.8 mm; *n*=218), 1.1 ±0.2 mm wide (range 0.5 – 1.5 mm; *n*=218). Ray florets carpellate, fertile, usually 20 ±4 per head (range 14 – 25; *n*=10); ligules yellow, 3 – lobed, tube glabrous to sparsely or, occasionally, moderately pubescent, upper surface glabrous and eglandular, lower surface sparsely to moderately pubescent and sparsely to moderately dotted with sessile glands, 12.4 ±2.0 mm long (range 9.0 – 16.8 mm; *n*=187), 4.5 ±1.0 mm wide (range 2.8 – 7.1 mm; *n*=187). Disc florets hermaphroditic, fertile; corollas yellow with yellow lobes, 5-lobed, constricted the lower one-sixth to one-fourth into a yellow-brown tube, cylindric to cylindric campanulate, glabrous below, sparsely to moderately pubescent on the lobes, eglandular to sparsely dotted with sessile glands, 2.5 ±0.3 mm long (range 2.1 – 3.0 mm; *n*=100), 0.7 ±0.1 mm in diameter (range 0.5 – 1.0 mm; *n*=100), the tube 0.5 ±0.1 mm long (range 0.2 – 0.7 mm; *n*=100). Achenes obconic to narrowly obconic, surface silver-white, moderately to densely pubescent with straight, forked, antrorse hairs, moderately dotted with sessile and impressed glands, 2.2 ±0.2 mm long (range 1.9 – 2.6 mm; *n*=100), 0.7 ±0.1 mm in diameter (range 0.5 – 0.9 mm; *n*=100). Pappus scales usually 7 ±1 (range 5 – 8; *n*=100), obovate, apex rounded to obtuse, not awned, 1.3 ±0.1 mm long (range 1.0 – 1.7 mm; *n*=100), 0.7 ±0.1 mm wide (range 0.5 – 1.0 mm; *n*=100). Chromosome number: $2n = 15_{II}$.

Distributed in South Texas in the vicinity of Brooks, Hidalgo, Jim Hogg, and Zapata counties (Fig. 2), growing in sand at roadsides and in pastures. Flowering December to June, mainly in March and April.

TYPE: U.S.A. TEXAS. Brooks Co.: Hwy 3066, 14.3 mi W of hwy 281 (jct S of Falfurrias), infrequent at roadside in deep sand, some plants 30 cm or more in diameter, 20 Mar 1991, *Bierner 91-13* (HOLOTYPE: TEX; ISOTYPES: NY, US).

Additional specimens examined: TEXAS. **Brooks Co.:** Hwy 281, ca 10 mi S of Falfurrias, 21 Apr 1949, *Lundell 14913* (GH, LL); 9 mi N of Encino, 4 Jun 1945, *Lundell & Lundell 13789* (LL); Hwy 281, 10.7 mi S of hwy 285 (jct in Falfurrias), $2n = 15_{II}$, 15 Apr 1988, *Bierner 88-35* (SWT, TEX); Hwy 281, 10.9 mi S of hwy 285 (jct in Falfurrias), 22 Apr 1989, *Bierner 89-4* (SWT, TEX); Hwy 285, 5.2 mi E of hwy 1329 (jct ca 9 mi W of Falfurrias), $2n = 15_{II}$, 20 Mar 1991, *Bierner 91-12* (SWT, TEX). **Hidalgo Co.:** Hwy 490, 5.7 mi W of hwy 281, 20 Mar 1991, *Bierner 91-14* (SWT, TEX). **Jim Hogg Co.:** Hwy 285, 5 mi E of Hebbronville, *Fowler & Vergara 70* (TEX). **Zapata Co.:** 5.5 mi NE of San Ygnacio on rd to Aguilares, 16 Mar 1966, *Correll 32248* (LL); ca 4 mi NE of San Ygnacio, 13 Dec 1967, *Correll 35453* (LL).

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BOOK REVIEWS

EVERSMAN, S. and M. CARR. 1992. **Yellowstone Ecology: A Road Guide.** Mountain Press Publishing Company, P.O. Box 2399, Missoula, MT 59806. $12.00. 242 pp.

This well-written, easily readable publication artfully leads the reader through the diversity of habitats comprising the Greater Yellowstone ecosystem, a 14 million acre complex containing Yellowstone and Grand Teton National Parks and surrounding highlands and plains. A true road guide, the book explores this vast region from 28 different roadway segments; each with an accompanying map and description of points of interest. Along the way, the book reveals many unique aspects of Yellowstone ecology.

Included in the book are informational sections on general ecology as it relates to the Greater Yellowstone ecosystem; specifically the topics of geology and climate, vegetation patterns and wildlife distributions and ecology. Also included are a glossary of terms and a section of selected readings.

Yellowstone Ecology: A Road Guide is an excellent tool for both the novice ecologist and the academician intent on exploring and understanding the natural setting of this most pristine environment.—*Joseph F. Kuban Jr.*

FRANKEL, E. 1991. **Poison Ivy, Poison Oak, Poison Sumac and their relatives, pistachios, mangoes, cashews.** The Boxwood Press, 183 Ocean View Blvd., Pacific Grove, CA 93950. Paper $9.95 + $1.25 postage. 98 pp.

This non-technical book is a valuable source of information for those individuals, three out of four, that are sensitive to these plants.

The Chapter titles are: 1) Is It Poison Ivy? 2) Climbing Poison Ivy, 3) Non climbing Poison Ivy, 4) Poison Oaks: East and West, 5) Sumacs: Harmful and Harmless, 6) Relatives of the Toxicodendrons, 7) Tales of the *Toxicodendron* Toxins: Fact and Fiction, 8 *Toxicodendron* Dermatitis, 9) Prevention and Treatment of the *Toxicodendron* Terror, 10) Controlling Toxicodendrons, 11) In Praise of Toxicodendrons.

The Appendices include: The Ten *Toxicodendron* Tenets, Key to Some Common Native Species of *Toxicodendron* and *Rhus*, and Books and Periodicals followed by the Index.

Line drawings and black and white photographs illustrate the text discussion making it very readable.—*Wm. F. Mahler.*

ON THE HISTORY OF *AGAVE ASPERRIMA* AND *A. SCABRA* (AGAVACEAE) AS WELL AS SOME TAXA OF THE *PARRYANAE*

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ABSTRACT

An evaluation of available literature, as well as the historical connections and an original photograph from the herbarium at Berlin-Dahlem (B) shows that *Agave scabra* Salm-Dyck cannot be an older name for *A. asperrima* Jacobi, as interpreted by Gentry, but rather belongs to the complex of *A. parryi* Engelm. Because of *A. scabra* Ortega, *A. scabra* Salm-Dyck becomes an illegitimate younger homonym and *A. wislizeni* Engelm. again is legitimate. The three subspecies described by Gentry for *A. scabra* Salm-Dyck are here combined with *A. asperrima*. To equalize species rank *Agave neomexicana* Wooton & Standley is treated as a new subspecies of the variable *A. parryi*.

ZUSAMMENFASSUNG

Eine Auswertung der verfügbaren Literatur, sowie die historischen Zusammenhänge und ein bisher unveröffentlichtes Originalphoto aus dem Herbarium Berlin-Dahlem (B), zeigen, daß *Agave scabra* Salm-Dyck kein älterer Name für *A. asperrima* Jacobi sein kann, wie Gentry interpretierte, sondern vielmehr dem Komplex um *A. parryi* Engelm. zuzuordnen ist. Wegen *A. scabra* Ortega ist *A. scabra* Salm-Dyck allerdings ein illegitimes, jüngeres Homonym, wodurch *A. wislizeni* Engelm. wiederum legitim wird. Die drei von Gentry für *A. scabra* Salm-Dyck beschriebenen Subspezies werden mit *A. asperrima* neu kombiniert. Im Interesse einer Angleichung des Artranges innerhalb der Gattung *Agave*, wird *A. neomexicana* Wooton & Standley neu als Subspezies der variablen *A. parryi* statuiert.

By detailed investigation of literature this contribution clarifies the following questions: (1) What is the identity of *A. scabra* Salm-Dyck? (2) Is *A. wislizeni* Engelm. an illegitimate name? (3) What is the status of *A. parrasana* Berger? (4) Has *A. asperrima* Jacobi priority over *A. scabra* Salm-Dyck? (5) How to rearrange the complex of *A. parryi* Engelm?

(1) **Agave scabra** Salm-Dyck

At the end of July 1849 Georg Albano von Jacobi (Fig. 1) got an *Agave* from the botanical garden of Freiburg/Br. The garden originally received it from Dr. Wislizenus from Chihuahua. Engelmann (1875:320) wrote concerning that taxon: "This interesting species was discovered by Dr. A. Wislizenus on the celebrated march of Doniphan's corps through northern Mexico, on the Nazas River near San Sebastiano, in the southeast corner of the State of Chihuahua, not

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FIG. 1. General Georg Albano von Jacobi (9 Apr 1805, Düsseldorf; † 2 Nov 1874, Berlin), monographer of the genus *Agave* and author of *Agave asperrima* (with kind permission of Jan Wartenberg, Berlin).

far east from Parras, May 10, 1947, in fl. and fr. Living shoots were sent by me to Prince Salm and seeds to different European correspondents, among others to Prof. A. Braun of Freiburg."

Jacobi saw, "1856 the same plant in multiple propagation, but without a name, in the garden of Munich," and further explained (1865:124): "As the Prince Salm dealt in 1858 with the writing of his paper on the agaves of his garden, we communicated to him description and leaves of the then unnamed and undescribed species of *A. scabra, A. jacobiana, A. uncinata,* and *A. variegata* for the eventual inclusion of these species in his arrangement." Indeed Salm-Dyck (1859:89) published the diagnosis of his *A. scabra* and explained: "This plant, which is growing at Chihuahua and germinated in our garden from seed, which Dr. Wislizenus sent to Germany, was often confused with *A. tehuacanensis*." The latter today is regarded as a synonym of *A. salmiana* Otto ex Salm-Dyck.

Jacobi (1865:124) accepted *A. scabra*, but placed it near *A. potatorum* Zucc. on the basis of habit. He described the specimen of his own collection, emphasizing that: "Both sides of the leaf are totally smooth and so the mention by the Prince that these are scabrous is an error." In the same month Koch (1865a:94) argued: "The roughness [of *A. scabra*], on which the Prince apparently states a high value, was not so noticeable on the specimens at my disposal. Do we no longer possess the true plants?" Regarding Jacobi's remark, he further explained: "But one cannot suppose, that an experienced botanist as the Prince Salm-Dyck, should have made such a mistake that he described something scabrous as smooth."

There is the question, whether Salm-Dyck and Jacobi described indeed two different agaves. The former wrote of "foliis asperis," the latter of "absolutely smooth" leaves. One has to remember that many characters of a diagnosis are subjective. Further, different authors often use a different vocabulary in describing similar plants. Many mentioned characters are not absolute but relative, such as "multi-leaved, bright apple-green, lanceolate, spine strong, teeth remote," etc. Even "asper" is a relative judgment. The leaves of agaves are in one extreme glossy-smooth, in the other extremely asperous, like sandpaper. However, it is my experience that the character of the leaf surface is relatively constant, rather independent of the age or culture of the species.

Koch (1865b:186) noted "*A. scabra* of most of our gardens is nothing more than one of the many forms under which *A. scolymus* (= *A. potatorum*) occurs. The plant of Salm-Dyck of this name seems to be lost, for it no longer exists at castle Dyck near Neuss; what is cultivated there now is the same form of *A. scolymus*..." If, however, *A. scabra* at castle Dyck was still authentic material, which is plausible, Koch considered the leaves smooth, too. He continued: "Following him [Salm-Dyck] his *A. scabra* was often confused with *A. tehuacanensis*, thence they all must be closely allied." This sounds logical, but basically it is possible, too, to confuse the names of totally different plants. If this happens "often," the confused specimens came most probably from the same origin. Indeed Salm-Dyck (1859:89) listed *A. scabra* in his arrangement directly behind *A. tehuacanensis*, which seems to support Koch's thesis. But note that his systematics is based on the character of the teeth, thus both taxa fell in the group "Macracanthae." Indeed

A. tehuacanensis was not described until 1859 by Salm-Dyck, but had been known for several years (Otto 1842) under the latter name in the gardens and had originally been introduced by Karwinski. A photograph of an original (?) plant from the Munich Botanical Garden (Berger 1915:146) seems to confirm that this taxon is a synonym of *A. salmiana* as this species is growing together with others around Tehuacan, Mexico.

Koch (1865a:86) further pointed out: "The roughness of the leaves must, on the contrary, have been very noticeable to him [Salm-Dyck], for he gave this species the name "the rough Agave" (*A. scabra*) because of this characteristic. And if he really had made his first diagnosis in error, he would surely not insist on his error and not say the truth." Surely Koch is right. But it should be noted that Salm-Dyck (1861:179) not only expressed *A. scabra* was rough, but rather affirmed its importance: "It is and remains one of the best characterized species." Furthermore, it is uncertain whether Salm-Dyck actually chose the epithet "scabra," himself, for he (1859:89) writes regarding *A. tehuacanensis*: "It was sent to me later—if I'm not wrong, from the Munich garden—under another name, *A. scabra*." From that it can be concluded the name *A. scabra*, at least there, existed before. It is surely possible that the plant known in gardens as *A. tehuacanensis* was erroneously treated in Munich as *A. scabra*. Why Salm-Dyck used this epithet for his *A. scabra* cannot be explained, since he was free to choose a more appropriate name. But he did not publish the name as *A. scabra* "Hort. Monac.," as, e.g., *A. mitis* Hort. Monac.

Salm-Dyck pointed out that "[*A. tehuacanensis*] is closely allied to *A. potatorum* regarding the teeth, but is totally different in its less numerous leaves, which are longer (45 cm), at the base (7.5 cm) broad, and with the spine tapering." Further he wrote in his Latin diagnosis, of "foliis asperis" too, which Jacobi (1864:560) commented on: "The first diagnosis. . .corresponds very well with the characteristics, with the only exception that the surfaces of the leaves are described as rough, what is not the case." Indeed the leaves of *A. salmiana* (*A. tehuacanensis*) are not really rough. This is another indication there was no agreement between Jacobi and Salm-Dyck over the meaning of "asper."

(2) **Agave wislizeni** Engelm.

Salm-Dyck (1859:89) described the leaves of his *A. scabra* as "rhomboid-oblong" and wrote: "It differs (from *A. tehuacanensis*) by more numerous leaves, not tapering, but becoming broader, only 5 inches long and 2 – 2.5 inches broad (at the broadest point)." This is a leaf-index (broadness/length) of 0.4 to 0.5. He continued: "This species, which we have cultivated for 11 – 12 years [starting about 1847], is apparently one of the smallest in the genus." Jacobi (1865:124) described the leaf-form of his 16-year-old plant as "short-rhomboid. . .5 inches long. . .at 2/3 of its length 3.5 inches broad..." Hence a still higher leaf index of 0.7; however, it is quite clear that Jacobi, as well as Salm-Dyck, were observing

plants with short and broad leaves which, judging by historical events, go back to the same collection by Wislizenus.

It is not quite clear on what plant Salm-Dyck based his *A. scabra*. He spoke only of "in our garden germinated from seed" and "which we have cultivated for 11 – 12 years." We must assume he is not speaking of himself here as Prince in the royal plural "pluralis majetatis" (designation by the plural "we"), since he wrote in the same article "I" and "my garden." In any case he did not expressly mention Engelmann as the source of the "offshoots" sent to him. He wrote: "This plant, which is growing at ["bei"] Chihuahua, germinated from seeds sent to Germany by Dr. Wislizenus..." Jacobi (1865:123) on the contrary spoke of "seeds... which the garden {Freiburg/Br.} received from Dr. Wislizenus from ["aus"] Chihuahua." This difference between "at" and "from" (bei/aus) is, of course, important.

In most cases it is possible to evaluate the identity of an *Agave* with a known location, even if the description alone is not clear. Engelmann (1875:320) reported the seeds he sent to Prof. Braun of the Freiburg/Br. Botanical Garden were collected "on the Nazas River near San Sebastiano, in the southeast corner of the state of Chihuahua, not far east of Parras, May 10, 1847." The delightful travelogue of Frederick Adolphus Wislizenus (1848) contains a relatively precise description of the journey on 10 May 1847. Figure 7 shows the travel route during May 1847. The Hacienda San Sebastian lies at the Rio Nazas, the boundary between Durango and Coahuila, west of Parras and east of Mapimi. Wislizenus (1848:67) believed the 2 days before passing the village of Pelayo, about 60 km northeast of Mapimi (Type locality of *Echinocereus flexispinus* Engelm.), were spent in Durango. However, Engelmann considered the epithet "scabra" of Salm-Dyck not suitable and explained: "As thus the published name is inadmissible, I deem it proper to substitute for it that of the discoverer of this and so many other interesting plants of Northern Mexico." In his description of *A. wislizeni* he wrote: "The leaf of the wild plant, now before me, is 8 inches long and 4 wide..." This is a leaf-index of 0.5.

Johnston (1944:78) gave the location of San Sebastian as "10 km northeast of Torreon" and stated that neither *A. scabra* nor *A. wislizeni* grows there, but rather *A. asperrima* Jacobi. On the occasion of an expedition in May 1973, Gentry (1975a) studied this case and reported: "During the 126 years after Wislizenus, the country has been much changed by man's increase and industry. There are no Agaves about the ruins of the Hacienda San Sebastian. All the flat land about there for 8 – 15 miles is occupied by intensive agriculture and outlying industries of the cities of Torreon and Gomez Palacio. On the chance that Wislizenus may have collected his seeds on the way from Mapimi to San Sebastian, I checked the old mule trails coming down the eastern bajadas of the Sierra Sarnoso. Along the eastern base of this limestone range, about ten miles west of San Sebastian, there is a fine stand of what has been long recognized as *Agave asperrima* Jacobi. Some of these plants follow the rocky bajadas to the border of the cleared farm land. This

is a widespread variable species in the Chihuahuan Desert and the only paniculate Agave I located near San Sebastian and the lower Rio Nazas. Wislizenus rode through this area on May 10, 1847, the day he reached San Sebastian (Wislizenus 1848:68). These plants all have the scabrous leaves and the reflexed teeth as described by Salm from his young specimens (11 – 12 years old). *Agave scabra* Salm-Dyck (1859) has priority over *A. asperrima* Jacobi (1864) and, according to my interpretations, should replace the latter in usage."

Gentry further considered *A. wislizeni* and *A. parrasana* Berger as conspecific, but classified Berger's taxon of the Sierra Parras as a subspecies. He assumed that Wislizenus collected seeds of two different Agaves: first from *A. asperrima* (=*A. scabra* sensu Gentry) at the Sierra Sarnoso and the next day, during the ride to Parras, from *A. wislizeni*. He wrote: "I have a collection (*Gentry 11546*) from the lower elevations of that range, a few miles east of Parras, what is not far from the trail Wislizenus followed...He may have considered the two collections as of one species and had no time or energy to make a note of it." This interpretation sounds plausible, since mixed collections cannot be excluded. Finally Gentry stated (1975a:104): "General von Jacobi might have cleared up the confusion about the seeds, if he had visited Prince Salm's garden. Apparently he was too busy naming species and made another synonym. Did that Old World rivalry deter him from visiting Prince Salm's garden? What sort of man was he anyway?"

If one reads the whole work of Jacobi, one can conclude this author always speaks with high esteem of Prince Salm-Dyck. Like the latter he tried, too, to follow the original sources of the described Agaves. Both realized the insufficiency of their systematic-taxonomic work and were not afraid to correct earlier false diagnoses. One absolutely cannot infer from the known literature that there was rivalry between these two respectable gentlemen. Of course a visit by Jacobi to Salm-Dyck would have cleared up this case. But if one looks at this from Jacobi's view, it was for him quite clear. He sent leaves and a diagnosis of a short- and broad-leaved, slow-growing *Agave*, which was raised from seeds collected by Wislizenus in Chihuahua, to Salm-Dyck, who published this plant the next year with the same field data. The only difference between the two diagnoses was the word "asper." Further, Salm-Dyck was surely considered by Jacobi to be an authority on agaves at that time. He began five years later to publish his monograph, which became a standard on *Agave*. The mobility of that time was quite different than today. Salm-Dyck spent the winter 1859/60, following his own account (1861:177), in Pau, near the Pyrenees; the following winter, 1860/61, in Nice, where he died 21 March 1861. Consequently there remained little time for a meeting after Salm-Dyck's publication in April 1859.

After F.S. Crosswhite and R. McVaugh (pers. comm. to H.S. Gentry) called attention to the fact the name *A. wislizeni* was illegitimate (Art. 11, ICBN), Gentry (1975b) published a short notice and concluded that "The correct name

for these taxa is *Agave parrasana* Berger." Surprisingly, his recently established differentiation of two taxa (*A. wislizeni* and *A. wislizeni* ssp. *parrasana*) was abandoned after a few months in favor of one taxon. Nowhere is there an explanation given why *A. wislizeni* now is not called something different and presented as a subspecies of *A. parrasana*. In his monograph Gentry (1982) accepted only *A. parrasana*, with *A. wislizeni* as an illegitimate synonym. But in the exsiccatae the type of the latter (*Wislizenus 280*) is not listed under *A. parrasana*. I made an attempt to clear up all questions involved and sent a letter to Dr. Gentry, who just in January 1986 had informed me, "I do not work with Agaves any more." So it was not surprising his answer (17 Nov 1990), unfortunately, contained no further information.

Gentry used the spelling "wislizenii." Following the recommendation 73.C2 of the ICBN, the genitive form of Wislizenus, "wislizeni," should be used, just as Engelmann did.

During the documentation of all taxa ever published for the Agavaceae, I found somewhat by accident in fasc. 2 of *Novarum aut rariorum plantarum*...by Ortega (1797) the well-done description of *Agave scabra*. This taxon was overlooked in *Index Kewensis*. Following today's delimitation of genera in the Agavaceae, this species belongs to *Manfreda* (tribe *Polianthеae*). McVaugh (1989:234) transferred the name to *Manfreda* and accepted its priority over *Manfreda brachystachya* (Cav.) Rose. The history of the latter species is well worth a more exhaustive study and will be given elsewhere. There are reasons that make McVaugh's synonymy plausible, but one interesting detail should be given here. Ortega diagnosed "foliis margine cartilagineo scabris," but Cavanilles wrote (1803:453) "foliis...integerrimis glabris." This is a really remarkable analogy to the "scabrous," respectively "smooth," leaves of *A. scabra* Salm-Dyck. The existence of Ortega's *A. scabra* affects the nomenclature:

1. *Agave scabra* Salm-Dyck is a younger homonym of *A. scabra* Ortega and according Art. 64 (ICBN) illegitimate.
2. If *A. scabra* Salm-Dyck is illegitimate, *A. wislizeni* cannot be illegitimate too. (This is the opinion of N.P. Taylor (submitted kindly from Dr. U. Eggli in a letter of 26 Sep 1990) and of Dr. W. Greuter [pers. comm. of 5 Oct 1990]). Therefore the name for this taxon must be *A. wislizeni*.

What is the identity of *A. scabra* Salm-Dyck, the later *A. wislizeni*? The obituary of G.A. von Jacobi (Anonymous 1875) mentions his proposal to publish his *Versuch zu einer systematischen Ordnung der Agaveen* in an edition with many photographs. Jacobi died in 1874 and this project was never realized. But in a listing, Dr. Koeber, curator of the botanical collection of the Schlesische Gesellschaft at Breslau, wrote under point four: "carton oversize-folio, containing a very great collection of photographs of Agaveen (very valuable)." I received on

FIG. 2. Authentic photograph of Jacobi's specimen of *Agave scabra* Salm-Dyck, the later *Agave wislizeni* Engelmann, as deposited in the herbarium of the Botanical Garden at Berlin-Dahlem (B).

18 Sep 1989 a letter from Dr. E. Panek (kindly transmitted from Dr. H.G. Richter, Hamburg) with a listing of the deposited photographs of Jacobi's residue in the herbarium of Breslau. During a visit to the herbarium of the botanical garden at Berlin-Dahlem, 2 to 5 Oct 1990, I found there doubtlessly authentic copies of Jacobi's original plates, with a stamp "H. Buchwald, Breslau." The photograph in figure 2 is reproduced for the first time, and shows *A. scabra* Salm-Dyck which Jacobi (1865:123/24) described. The compact growth, the short, broad leaves, and the armature place this Agave without doubt in the group "Parryanae." Salm-Dyck's affirmation (1861:179) "It is and remains one of the best characterized species," is absolutely justified, since at that time no other member of this group was known in European gardens. If *A. scabra* Salm-Dyck was not an illegitimate homonym of *A. scabra* Ortega, the well-established and persistently used name of *A. parryi* Engelm. would have been replaced by the former. Trelease (1912, pl. 75, 76) illustrated the type of *A. wislizeni* (*Wislizenus 280*, MO) and indeed this leaf corresponds well with Jacobi's plant.

Although the history of *A. scabra* could well have been explained here in the essential points, neither Johnston (1944) nor Gentry (1975a) could rediscover this species at the locality given by Engelmann (1875) as San Sebastian. There are basically two explanations:

1. Up to now, the search for *A. scabra* was confined to the environs of the old Hacienda San Sebastian and the foot slopes of the eastern Sierra Sarnoso. Nevertheless, this species could easily be found in the mountains between Mapimi and San Sebastian.
2. *Agave scabra* really does not grow there, Engelmann's statement notwithstanding, but the seed was collected previously, coming from Chihuahua or, as Gentry supposed, later on the travel to Parras.

The question is to what extent Wislizenus and Engelmann distinguished species of *Agave* as delimited today. The less this may be the case, the more is the possibility of mixed collections.

Wislizenus (1848:50 – 53) resided from 13 Sep 1846 to 3 Mar 1847 in Cusihuiriachic, about 90 km southwest of Chihuahua. Engelmann (Wislizenus 1848:102) remarked with regard to the plants collected there: "In fact almost everything collected there appears to be new!" Trelease (1912:86) arranged *A. wislizeni*, *A. parrasana,* and his *A. chihuahuana* side by side in his key. *Pringle 958* (MO, mountains near Chihuahua, 8 Sep 1886), a plant originally distributed as *A. wislizeni*, is cited as a type of the latter. *Rose 11654* (US, Chihuahua: Cosihuiriachic, 2 – 3 Apr 1908) and the photograph of this plant in the field (Trelease 1912: pl. 82(1)) correspond well with the picture of Jacobi's residue. Salm-Dyck's location for his *A. scabra* fits well here. In this light the conception of Johnston (1944) is obvious, treating *A. chihuahuana* Trel. as a synonym of *A. wislizeni*.

FIG. 3. *Agave parrasana* Berger growing in the Sierra Paila, Coahuila, Mexico. Photographed by Alfred B. Lau in Oct 1990.

(3) **Agave parrasana** Berger

Agave parrasana, described by Berger (1906), is frequently seen in European gardens, distributed via offshoots because of its compact growth and attractive armature. Although natural stands are scattered in the Sierras of Coahuila, access is not easy. The first picture is in Berger (1915; others are in Boss (1943) and Breitung (1964, 1968)). The members of the 'Parryanae' are rather similar to each other, except for *A. guadalajarana* Trel., but *A. parrasana* is easy to recognize in its typical form. *Agave parryi* is sometimes identified in collections as *A. parrasana*. Janse (1975) showed one such plant, an apparently very old specimen, in the "Städtische Sukkulenten-Sammlung" in Zürich. This particular plant flowered there in January 1990 (Eggli 1990). At a later stage of the inflorescence (April 18th) nothing was seen of the typical imbricate, fleshy bracts covering the shaft. Figure 3 gives a typical rosette from the Sierra Paila, Coahuila, photographed by A. B. Lau. Gentry (1973) found this plant there too. The exact position of *A. wislizeni* cannot be evaluated now because on one hand, the locality given by Engelmann could not be verified and, on the other hand, different indications point to a type locality near Chihuahua. Because *wislizeni* could lie closer to *A. parryi* than to *A. parrasana*, it appears to be premature to reinstate the combination *A. wislizeni* ssp. *parrasana* by Gentry (1975a), nor to follow the conception of Gentry (1975b, 1982) and replace *A. parrasana* by *A. wislizeni*.

FIG. 4. *Agave asperrima* Jacobi growing about 20 km north of Saltillo, Coahuila, Mexico. Photographed in Apr 1989 by the late Wilhelm Frey.

Where has *A. wislizeni* been collected? Notable is the statement of Trelease (1912:90): "Specimens which are still small occur in the living collections of the Missouri Botanical Garden, recorded as from Engelmann, and from these it is impossible to distinguish other specimens distributed from Lampazos, Nuevo Leon, by Mrs. Anna B. Nickels, under the name *A. noah*." He further (1912: pl. 79) showed a flowering specimen of *A. noah* at Fairmont Park in 1907. An excellent article on A.B. Nickels from Laredo, Texas, was published by Mitich (1971), where page 26 of her catalogue for 1894 (?) is reproduced. There *A. noah*

is described as follows: "The leaves of this plant are of pale ashy green color; are very wide and short, also very much turned up at the sides."

(4) **Agave asperrima** Jacobi

As shown here, *A. scabra* Salm-Dyck is not identical with *A. asperrima* Jacobi. In all major taxonomic works on *Agave* (Baker 1888; Berger 1915; Trelease 1920; Breitung 1968), *A. asperrima* was accepted. It is the most common member of the subgenus *Agave* of the northern central plateau of Mexico. Figure 4 shows a typical plant about 20 km north of Saltillo, Coahuila, photographed in 1989 by Wilhelm Frey (deceased). The habit is similar to *A. americana* L., but the leaves are very rough. Gentry (1982:286) mentioned natural hybrids between these two taxa, which he arranged in the "Americanae." These groups, as Gentry calls them somewhat informally, are to be interpreted as sections. If *A. americana* is the type of the genus, the correct name for this section is, following Art. 22.1 (ICBN), *Agave*. The name *A. asperrima* is also used in the Mexican literature, e.g., in Matuda (1965). I saw, in most European collections, this name for the plant under discussion.

Gentry's neotypification of *A. scabra* Salm-Dyck, an illegitimate name, is based on a misinterpretation of this taxon. The question of typification of *A. asperrima* is unresolved. Jacobi (1864:561) discussed a specimen of the Munich Botanical Garden, raised from seeds sent by F. Lindheimer from "Talmit." Prof. Dr. Martius, the late director of this famous garden, assumed Texas as the homeland of this plant. This is plausible, for indeed Ferdinand Lindheimer collected in that region about 1850. Jacobi's (1864) plant had leaves 30 cm long; it could well be possible the seed germinated ca. 1850. Despite great efforts I was unable to locate "Talmit" on any map of Texas, nor can this be found in the *Plantae Lindheimerianae* III (Blankinship 1907) or the *Aufsätze und Abhandlungen von Ferdinand Lindheimer* (Passavant 1879). It is really curious: there is a location given for *A. wislizeni*, but this taxon could not be found there today and the type locality "Talmit" of *A. asperrima* is unknown. The cited exsiccatae from Gentry (1982), and several additional locations from Galvan & Gonzales (1991), Berger (1915), and Synnott (1989) for the *A. asperrima*-complex, are indicated in Figure 7. Gentry lists *A. asperrima* for Starr, Zapata, and Webb counties, Texas, and as the most northeasterly location, Catarina in Dimmit County. Mulford (1896:89) wrote: "This plant (*A. asperrima*) is reported as occurring spontaneously in Texas at a point about twenty miles northeast of San Antonio, and at Eagle Pass. From the former place Mr. Gurney received a plant a number of years ago..." This is the more interesting, as New Braunfels lies only about 50 km northeast of San Antonio. Lindheimer, remembered today in a small museum in New Braunfels, collected, according to Blankinship (1907:150), the type of *Nolina texana* S. Watson at the "upper Cibolo," in March 1846. Cibolo Creek, at the southeast corner of the Edwards

Plateau, is today the boundary between Bexar Co. (San Antonio) and Comal Co. (New Braunfels) and lies about 20 miles northeast of San Antonio. These relations suggest the possibe type locality of *A. asperrima* lies in the northeasternmost part of its range in Texas. Unfortunately there are no cited exsiccatae of this species near New Braunfels and the illustration of a leaf, as shown by Mulford (1896: pl. 53[1–4]), was apparently drawn from a living specimen. Berger (1915:147) included this illustration in his *A. caeciliana* even if he in the description obviously is referring to living plants in La Mortola which C.A. Purpus had sent from Viesca in Coahuila. This taxon is at any rate a synonym for *A. asperrima*.

As I affirmed in September 1990, no specimen of *A. asperrima* is deposited in the Munich herbarium (M). The listing of Dr. Panek cites no material for the Breslau herbarium. Apparently no original material exists and it is necessary to select a neotype. This was the intention of Gentry (1975a), but since he referred to *A. scabra* Salm-Dyck, his selection is superseded (Art. 8.1(b), ICBN). Gentry's selection could be used for *A. asperrima*, but the map shows that *Gentry & Engard 23268* (US, Durango: Dinamitia, 15 May 1973) originated from the western limit of its range, many hundreds of kilometers southwest of the original location, as indicated by the reviewed history of *A. asperrima.*

The names of plants, collectors, or locations are often corrupted more or less. Dr. Almut G. Jones, curator of the University of Illinois herbarium (ILL), wrote (letter of 9 Apr 1991): "In Starr Co. (Texas), is a village 'Delmita'. Lindheimer has made many mistakes with geographical names, especially on the labels of herbarium specimens. I would view 'Delmita' as a good possibility."

Dr. Marshall C. Johnston (letter of 23 Jun 1991) wrote: "I doubt very much that Ferdinand Lindheimer ever travelled in what is now Starr Co., Texas, that lying about 450 km south of the southernmost point that he is known to have searched. I have no idea what is meant with "Talmit" unless the plant was growing in a Tal mit...anderen Pflanzen." Because Lindheimer sent the seed to Munich, he collected in Texas and *A. asperrima* is known today from the southern part of this state, there are historical reasons to assume Texas as the original locality. Of course it is possible that Lindheimer did not collect the seed himself, but only submitted it, together with other material of his own, to the Botanical Garden of Munich.

As neotype for *Agave asperrima* Jacobi I select: *Gentry & Barclay 20012* (U.S.A. TEXAS. Starr Co.: 8 km SE Saus, 7 Jun 1963; US; ISONEOTYPE: DES).

Jacobi placed *A. asperrima* side by side with *A. tehuacanensis* in his systematics, based on habit characters. Indeed young plants may be similar. The seedlings of the later *A. asperrima* could well have the name *A. scabra* within the Munich Botanical Garden. If during the next year the labels of these two taxa were interchanged in part, this could be the reason why (1) the name *A. scabra* existed within Munich Botanical Garden before the publication of Salm-Dyck (1859),

FIG. 5. *Agave asperrima* Jacobi ssp. *zarcensis* (Gentry) Ullrich near the type locality, about 15 km south of La Zarca, Durango, Mexico. Photographed by Ernst Wölfing 11 Jan 1991.

and (2) that he, as well as Jacobi, received from that institution plants of *A. tehuacanensis* as *A. scabra.* Gentry (1982) described three subspecies of *A. scabra* Salm-Dyck, which are given here as new combinations with *A. asperrima*:

Agave asperrima Jacobi ssp. **asperrima**, Hamburger Garten Blumenzeitung 20(12):561, Dec 1864. TYPE: TEXAS. Starr Co.: 8 km SE Saus, 7 Jun 1963, *Gentry & Barclay 20012* (NEOTYPE: US; ISONEOTYPE: DES).

A. caeciliana Berger, Die Agaven. 147. 1915.

Agave asperrima Jacobi ssp. **maderensis** (Gentry) Ullrich, comb. nov. BASIONYM: *A. scabra* Salm-Dyck ssp. *maderensis* Gentry, Agaves Continental North America 300. 1982. TYPE: MEXICO. Coahuila: Canyon de la Hacienda, Sierra Madera, NW Quatro Cienegas, 10 May 1973, *Gentry & Engard 23251* (HOLOTYPE: DES; ISOTYPES: MEXU, US).

Agave asperrima Jacobi ssp. **potosiensis** (Gentry) Ullrich, comb. nov. BASIONYM: *Agave scabra* Salm-Dyck ssp. *potosiensis* Gentry, Agaves of Continental North America 300. 1982. TYPE: MEXICO. San Luis Potosi: 27 km E Huizache jct along route 80, 16 Jul 1963, *Gentry et al. 20162* (HOLOTYPE: US; ISOTYPES: AMER, DES).

Agave asperrima Jacobi ssp. **zarcensis** (Gentry) Ullrich, comb. nov. BASIONYM: *A. scabra* Salm-Dyck ssp. *zarcensis* Gentry, Agaves Continental North America 302. 1982. TYPE: MEXICO. Durango:. along route 45, 24 – 32 km S La Zarca, 31 Oct 1966, *Gentry & Arguelles 22084* (HOLOTYPE: US; ISOTYPES: DES, MEXU).

Eggli & Taylor (1984) treated *A. scabra* ssp. *maderensis* as nom. inval. (based on syntypes, Art. 37.1, ICBN). Together with the information given by Gentry

FIG. 6. Fine plant of *Agave parryi* Engelm. ssp. *parryi*. Photographed by Ernst Wölfing, 10 Jan 1991, about 25 km west of Hidalgo del Parral direction El Vergel, Chihuahua, Mexico.

(1982:307) this taxon is legitimately published (pers. comm. with Dr. U. Eggli, 18 Apr 1990). I never saw this subspecies in European collections. The ssp. *potosiensis* is extremely scarce in culture, but in 1990 a fine specimen flowered in the Palmengarten of Frankfurt/M., which was collected by G. Andersohn east of San Luis Potosí. The plant had not been pollinated and formed no seeds, but an offshoot is in my collection.

Small plantlets, collected from the late W. Frey about 5 km south of El Palmito, Durango, in April 1989, could represent ssp. *zarcensis*. Seeds collected by Ernst Wolfing on 11 Jan 1991, about 15 km south of La Zarca near the type locality (Fig. 5), germinated very well.

(5) **Agave parryi** Engelm.

As shown here, *A. scabra* Salm-Dyck, the later *A. wislizeni*, is apparently related to *A. parryi*. In the last paragraph of this paper I shall give full synonymy of this most common taxon of the "Parryanae," including a new combination.

Agave huachucensis Baker is a highly ornamental plant often seen in gardens. It suckers profusely and is in general apparently a single clone. Such plants are always easy to recognize. Gentry (1972:119) accepted this taxon at the species rank but (1982:542) preferred the status as a variety of *A. parryi*, distinguished by larger leaves and flowers, as well as a broader panicle. Benson & Darrow (1981:73) mentioned its limited habitat as "an area less than 30 miles in diameter

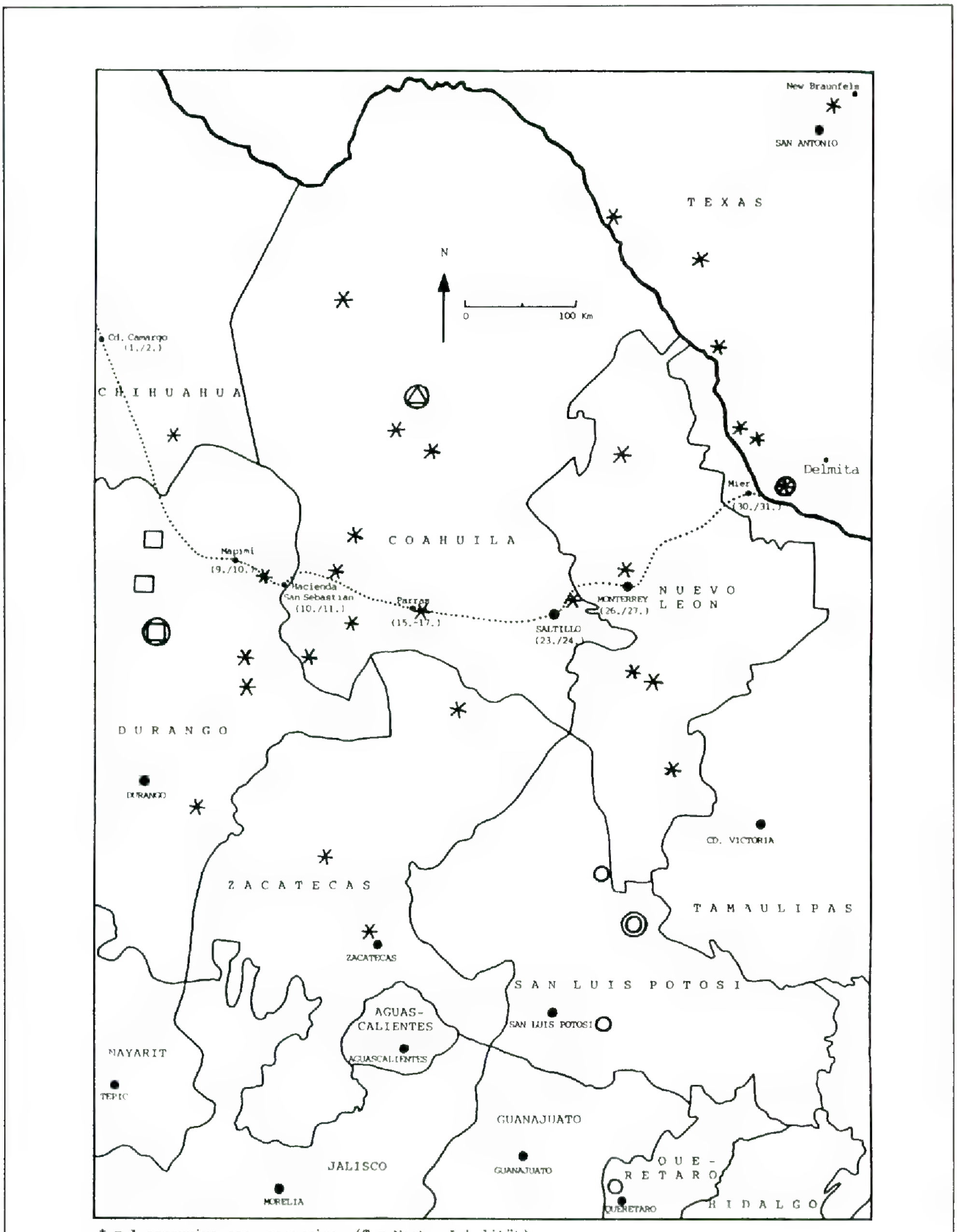


FIG. 7. Distribution of *Agave asperrima* ssp. *asperrima*, ssp. *maderensis*, ssp. *potosiensis*, ssp. *zarcensis* in Mexico.

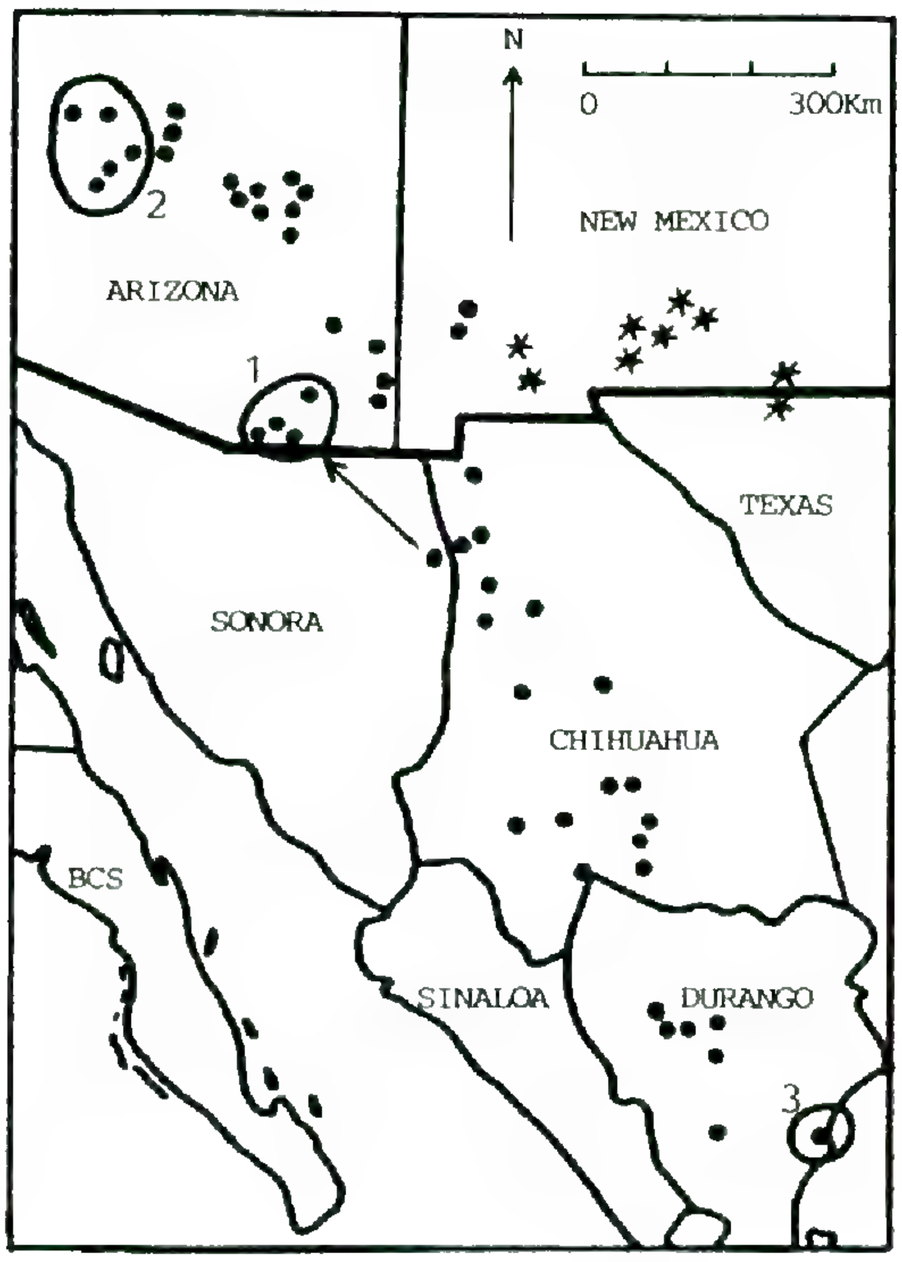
in southeastern Arizona" (Fig. 8). Skinner (1961) visited the population between Sonoita and Patagonia and remarked: "This section of the country is noted as being one of the moistest spots of the state." It is possible, that this environmental situation is responsible for the more robust growth of *A. huachucensis*. The flower lengths listed by Gentry (1982:525)—*A. huachucensis* with 62 – 81 mm, and *A. parry*i with 60 – 77 mm—show no clear distinction of the two taxa. Even the geographical separation of *A. huachucensis* is unclear, since certain plants from Durango, Mexico, have a similar habit, as indicated by a picture of a superb specimen (Ullrich et al. 1991). Furthermore the status varietal is unusual in modern *Agave* taxonomy for wild populations.

Gentry (1982:542) further accepted *A. couesii* Trel. as a variety of *A. parryi*, distinguished by smaller leaves and flowers. But here too, the flower length of 46 – 59 mm for *A. couesii* approaches the 60 – 77 mm for *A. parryi*. This form is growing in the northwesternmost corner of the wide distribution area of *A. parryi*. Perhaps the smaller growth is affected by the colder climate at the cold-fringe of "Agave-land." Gentry (1982:542/43) commented: "Small-leaved forms of *A. parryi*, however, occur at random elsewhere, as on the Sierra Ancha of Arizona (*Gentry 2231*) and again in central Chihuahua (*Gentry & Arguelles 22953*)." Benson & Darrow (1981) treated *A. couesii* as a synonym of *A. parryi;* I am inclined to accept this for the time being.

The form of *A. parryi* without marginal teeth described by Breitung (1964:76) as f. *integrifolia* grows side by side with *A. couesii* about 16 km SW of Prescott, Arizona. The suppression of teeth appears, following Gentry (1982:543), to be "a homologous character widely distributed in the genus *Agave*." Such forms are known, e.g., with *A. deserti* Engelm., *A. utahensis* Engelm. in King, *A. potatorum* Zucc., *A. fourcroydes* Lemaire, and *A. triangularis* Jacobi.

Agave parryi var. *truncata*, described by Gentry (1982) as new, is said to differ in its smaller, truncate leaves, "inflorescence as in *A. parryi*." He further wrote: "The wild plants appeared rather depauperate..." A specimen of the original collection flowered in 1977 in the Huntington Botanical Garden, San Marino, California. This plant was "relatively large," as Gentry admitted himself, and his photo (1982:544) shows a specimen that could fit without great problems in the *A. parryi*-complex. Different growth habit caused by climatic or edaphic factors disappears under equal garden conditions, but genetically affected differences remain. An offshoot of the HBG-plant developed in my collection (Ullrich 1991) within the normal range of variability of the whole complex of *A. parryi*. Gentry (1982:539) summed up: "A competent taxonomic segregation of these forms requires a detailed analytic field study beyond the limits of this work."

Agave parryi Engelm. ssp. **parryi**, Trans. Acad. Sci. St. Louis 3(20):311. 27 Dec 1875. (Figs. 6,8).



• = A.parryi ENGELM ssp. parryi

1 = plants described as A.huachucensis BAKER

2 = " " " A. couesii TRELEASE

3 = " " " A.parryi var. truncata GENTRY

★ = A.parryi ENGELM. ssp. neomexicana (WOOTON & STANDL.) ULLRICH

FIG. 8. Distribution of the complex of *Agave parryi* Engelm. (following Gentry 1982).

A. scabra Salm-Dyck, Bonplandia 7:89. 15 Apr 1859 (nom. illeg.) non: *A. scabra* Ortega, Nov. Rar. Pl. Hort. Reg. Bot. Matrit., Decas 2:13. 1797.

A. americana L. var. *latifolia* Torr., U.S. Mex. Bound. Survey 213. Apr 1859

A. wislizeni Engelm., Trans. Acad. Sci. St. Louis 3(20):320. 1875.

A. huachucensis Baker, Handb. Amaryll. 172.1888.

A. noah Nickels, Catalogue: 26.1894(?).

A. applanata Koch var. *parryi* (Engelm.) Mulford, Annual Rep. Missouri Bot. Gard. 7:83, pl. 36 – 39. 23 May 1896.

A. applanata Koch var. *huachucensis* (Baker) Mulford, Annual Rep. Missouri Bot. Gard. 7:85, pl. 40 – 41. 23 May 1896.

A. chihuahuana Trel., Annual Rep. Missouri Bot. Gard. 22 (1911):90, pl. 82 – 83. 14 Feb 1912.

A. patonii Trel., Annual Rep. Missouri Bot. Gard. 22 (1911):92, pl. 90, 14 Feb 1912.

A. couesii Trel., Annual Rep. Missouri Bot. Gard. 22 (1911):94, pl. 94 – 97, 14 Feb 1912.
A. parryi Engelm. var. *couesii* (Engelm. ex Trel.) Kearney & Peebles, J. Wash. Acad. Sci. 29(11):474, 15 Nov 1939.
A. parryi Engelm. var. *huachucensis* (Baker) Little, in Benson, Amer. J. Bot. 30(3):235. 12 Apr 1943.
A. parryi Engelm. f. *integrifolia* Breitung, Cact. Succ. J. (Los Angeles) 35(3):76. Jun 1963
A. parryi Engelm. var. *truncata* Gentry, Gentry, H.S: Agaves Continental North America 543. 1982.

THE STATUS OF *A. NEOMEXICANA* WOOTON & STANDLEY

Wooton & Standley (1913) compared *A. neomexicana* with *A. applanata*. Berger (1915) as well as Trelease (1920) made no mention of this species. McKechnie (1949:166) stated: "Its botanical name is *Agave parryi* Engelmann variety *Neo Mexicana*." It is not known that this combination has ever been made public before. Breitung (1968) as well as Benson & Darrow (1981:72) treated this taxon as a synonym of *A. parryi*. Gentry (1982) accepted *A. neomexicana*. Table 1 gives some characters of his diagnoses.

TABLE 1. Diagnostic characters of *Agave neomexicana* and *A. parryi*.

Character	*A. neomexicana*	*A. parryi*
Leaves (L × W)	20 – 45 × 5 – 12 cm	25 – 40 × 8 – 12 cm
Teeth (L)	5 – 7 mm	3 – 7 mm
Spine (L)	25 – 40 mm	15 – 30 mm
Inflorescence (H)	3 – 4 m	4 – 6 m
Branches	10 – 17	20 – 36
Flowers (L)	55 – 67 mm	60 – 75 mm
Tube (L)	12 – 14 mm	8 – 12 mm
Tepals (L × W)	15 – 20 × 3 – 4 mm	18 – 24 × 4 – 6 mm

The leaves of *A. neomexicana* tend to be somewhat more narrow, the inflorescence shorter, and the branches fewer. In comparison, the flowers of *A. neomexicana* at the type-locality (USA: New Mexico, Dona Ana Co.: Organ Mts., 22 km E Las Cruces, 18 Jun 1967, *Gentry 22304*) and of *A. parryi* (USA: New Mexico, Grant Co.: 5 km N Pinos Altos, 18 Jun 1967, *Gentry 22305*) are very similar. Both taxa are clearly very closely related. Their distribution areas are adjacent (Fig. 8). To equalize species rank within the genus *Agave*, I classify *A. neomexicana* as a subspecies of *A. parryi*.

Agave parryi Engelm. ssp. **neomexicana** (Wooton & Standley) Ullrich, stat. nov. BASIONYM: *Agave neomexicana* Wooton & Standley, Contr. U.S. Natl. Herb. 16(4): 115, pl. 48. 12 Feb 1913.

Agave parryi Engelm. var. *neomexicana* (Wooton & Standley) McKechnie, Cact. Succ. J. (Los Angeles) 21(6):166. 1949.

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BOOK REVIEWS

VIOLA, H.J. C. MARGOLIS. 1991. **Seeds of Change—Five Hundred Years since Columbus.** (ISBN 1-56098-036-2 pbk). Smithsonian Institution Press, Department 900, Blue Ridge Summit, PA 17294-0900. Paper $24.95. 277 pp.

Seeds of Change supports the Smithsonian Institution's Columbus Quincentenary exhibit, "Seeds of Change," that examines the monumental effect that corn, the horse, disease, potato and sugar have had on the Old and New Worlds. This volume is an attempt to examine consequences of Columbus stepping ashore and changing world history. There are 15 essays; Seeds of Change tells about the exhibit and how the book supports it; The Demise of the Fifth Sun is a history of the indigenous people that populated the New World; essay 3 and 4 is a history of the spread of new crops the Americas introduced to the Old World like maize, potatoes, sweet potatoes, tomatoes, peanuts, manioc, cacao, peppers, beans, squashes and new grape varieties. Essay 5 is The Metamorphosis of the New World. Essay 6 is about the influence of the horse on the New World. Essays 7 and 8 are about the profits provided by the plants of the New World and about the effects of slavery. Essay 9 is the history of old Galway's Plantation on Montserrat Island and presents as one of many to show the array of people, plants, animals and ideas of the New World. Essay 10 explains how African culture has influenced and enriched the culture of the Americas. Essay 11 is An American Indian Perspective. Essay 12 is Health and Disease in the Pre-Columbian World. Essay 13 is Three Faces of Eden. Face one being nature primeval, face two is nature modified, disturbed and despoiled by man's domination and destruction, and face three is the artificial or synthetic nature made by man. The last essay, Nature's Future addresses the problems and hopes for the future. There are 165 color and 162 black and white photographs. Historians, conservationists, anthropologists, and botanists will find this book worth reading.—*Dotty Woodson.*

SEGERBÄCK, L.B. 1992., **Orchids of Malaya.** (ISBN 90 6191 700X) A.A. Balkemia, Old Post Road, Brookfield, VT. 05036. Hbk. $120.00 168 pp.

Segerbäck's listing and description of 130 Malayan species will be a valuable source for orchid growers, researchers and botanists. There are 229 black and white and 26 color photographs. The glossary defines taxonomic terms special to orchids. The text includes a key to the genera, a description featuring each subfamily and genus. Each entry includes a thorough botanical description of the genus and each species found in Malaya. Distribution for other parts of the world are given. This book is a reference that will be appreciated by orchidists for years.—*Dotty Woodson*

A REEVALUATION OF THE GENUS *PHYLLOSTYLON* (ULMACEAE)

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ABSTRACT

Since its circumscription in 1880, *Phyllostylon* has been attributed with between one and three species. A morphological reevaluation of the genus justifies the recognition of two species, *Phyllostylon brasiliense*, restricted to eastern coastal Brazil, and *P. rhamnoides*, ranging from Mexico to Paraguay and the West Indies. Descriptions of the two species, notes on the type specimens, and a map are included.

RESUMEN

Desde su delimitación en 1880, a *Phyllostylon* se le han asignado entre una y tres especies. La reevaluación morfológica del género permite reconocer dos especies, *Phyllostylon brasiliense* restringida al este de Brazil, y *P. rhamnoides* que abarca desde Mexico hasta Paraguay y las Antillas. Se incluye la descripción de las dos especies, notas sobre los ejemplares tipos y un mapa.

Phyllostylon is a small neotropical genus in the Ulmaceae that has been reported to have between one and three species. The genus ranges from Tamaulipas, Mexico, to Paraguay, as well as Cuba, Haiti, and the Dominican Republic, and is found frequently in dry scrub forest. The genus clearly belongs in the subfamily Ulmoideae by virtue of its bisexual flowers and dry, winged fruits, yet is distinguished from the other five genera in that subfamily (*Hemiptelea*, *Holoptelea*, *Planera*, *Ulmus*, *Zelkova*) by samaras that are elliptic or sickle-shaped in outline, not round. Anatomical studies detailing fruit development and the structure and ontogeny of the anther and ovule of *Phyllostylon* (Dottori 1989, 1991) confirm its position in the Ulmoideae and give further evidence to its uniqueness in the subfamily.

The genus *Phyllostylon* was published by Bentham and Hooker (1880) for G. S. Barao de Capanema, a professor in Rio de Janeiro who corresponded with Hooker between 1850 and 1870. Since the publication of the genus with the type species, *P. brasiliense*, one additional name has been published in that genus and another genus has been transferred into it. In 1888, Poisson published *Samaroceltis,* a new genus in the Ulmaceae. Two years later this new species was correctly transferred into *Phyllostylon* (Taubert 1890). The third and most recent name published in *Phyllostylon* is *P. orthopterum* Hallier.

Confusion concerning the species concepts in *Phyllostylon* became evident when the author was preparing a treatment of the Ulmaceae for the Flora de

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Nicaragua. In his synopsis of the genus, Pereira (1971) recognized all three names as distinct species. In a recent flora Nee (1984) recognized only one species, *P. brasiliense*, the other two names being placed in synonymy. Because of these discrepancies in species concepts within *Phyllostylon*, a reevaluation of the genus was undertaken. Morphological examination of type material and over 200 specimens indicate the distinction of a species along coastal Brazil from a wide ranging neotropical entity. A key separating the two species, descriptions and discussion of the species, as well as a map, follow.

Phyllostylon Capanema ex Bentham & J. D. Hooker, Gen. Pl. 3:352. 1880.—
TYPE SPECIES. *Phyllostylon brasiliense* Capenema ex Bentham & J. D. Hooker.

Samaroceltis Poisson, Compt. Rend. Assoc. Franc. avanc. sci. 16ième sess. 2:595. 1888.

Unarmed, andromonoecious trees or shrubs with stiff irregular branches. Leaves alternate, serrate, pinnately nerved, petiolate, with cystoliths; stipules small, lateral, free, caducous. Inflorescences fasciculate in the axils of fallen leaves, lower flowers staminate, upper flowers functionally pistillate. Flowers with a 5-parted perianth, segments imbricate; stamens 5; ovary sessile, compressed, with two unequal style branches. Fruit a compressed samara, terminated by a large membranceous unequal falciform wing, with another small wing at base, the enlarged seed cavity irregularly ribbed, puberulent; seed with thin testa; endosperm absent; embryo straight.

Distribution. Two species, one in central coastal Brazil and the other wide-ranging from Mexico, Central America and the West Indies to Venezuela, Colombia, Bolivia, Argentina, Paraguay, and central Brazil.

KEY TO THE SPECIES OF *PHYLLOSTYLON*

1. Leaves long acuminate, drying smooth on upper surface; lateral veins flush with lower surface; fruits with the larger wing broadly cuneate, acute at apex, the dorsal edge straight, the smaller wing 3 – 6 mm long; coastal Brazil (Bahia, Minas Gerais, Pernambuco, Rio de Janeiro). ..... 1. *P. brasiliense*
1. Leaves acute, retuse or obtuse, drying scabrous on upper surface; lateral veins raised below; fruits with larger wing elliptic to narrowly cuneate, rounded to acute at apex, the dorsal edge usually curved, sometimes straight, the smaller wing (4-)7 – 10 mm long; West Indies, Mexico, Central America, Venezuela, Colombia, Bolivia, Argentina, Paraguay, central Brazil. ..... 1. *P. rhamnoides*

1. **Phyllostylon brasiliense** Capanema ex Bentham & J. D. Hooker, Gen. Pl. 3: 352. 1880. TYPE: BRAZIL. *Capanema s.n.* (HOLOTYPE: K!) [See discussion below].

Trees 5 – 13 m tall with brittle gray branches; older stems gray becoming lighter with age; younger stems light brown to gray, puberulent. Leaves elliptic 2.2 – 4.1(-7.3) 3 1.2 – 1.9(-3.6) cm, long acuminate at apex, round to subcordate and usually oblique at base, margins serrate with 2 – 10 prominent teeth on each side with teeth beginning 1/2 to 1/3 distance from base of lamina, drying smooth, glabrous or sometimes sparsely puberulent above, midvein puberulent above,

puberulent beneath, the lateral veins flush with lower surface, tertiary venation not drying conspicuously darker beneath; petioles 1 – 2(-3) mm long, puberulent; stipules small, 2 – 4 mm long, puberulent, caducous. Inflorescences fascicles borne in the leaf axils, usually appearing after the leaves have fallen, lower flowers staminate, upper flowers bisexual. Flowers borne on short peduncles 2 – 8(-9) mm long; sepals 5, 1.5 – 2 mm long, lanceolate, sparsely puberulent externally; stamens 5, filaments ca. 1 mm long; staminate flowers mostly without pistillodes, perfect flowers with a compressed sessile ovary, the two style branches unequal. Fruit a samara, 2.8 – 4.0 3 1.0 – 1.5 cm with two membranaceous wings; the enlarged seed cavity irregularly ribbed, puberulent; the larger wing 2 – 2.7 cm long, 1 – 1.5 cm broad, broadly cuneate, the apex acute, the dorsal edge usually straight, the smaller wing 3 – 6 mm long, narrow and curved inward.

Common names. Brazil: carne d'anta, rama branca, vareteiro.

Distribution (Fig. 1) *and phenology.* Found only on the Atlantic coast of Brazil from the states of Bahia, Minas Gerais, Pernambuco, and Rio de Janeiro. Habitat information not available. Flowering specimens have been recorded from May and July, while fruiting specimens have been collected in September and October.

Representative specimens examined. Brazil. Bahia: km 9 estrada Serra Preta-Ipirá, 205 m, 24 Nov 1970, *Andrade-Lima 70-6109*. Minas Gerais: Figueira, *Directoria Geral do Serviço Florestal do Brasil 1476* (MO); rd. between Vitória and Figueira, *Kuhlmann 251* (F, US). Pernambuco: Aguas Belas, propriedade Fazenda Nova, Serra do Cumunati, 29 Nov 1969, *Andrade-Lima 69-5616* (F-2 sheets). Rio de Janeiro: Rio de Janeiro, *Capenema s.n.* [RB *17991*] (MO, US); São Cristovao, 22 May 1885, *Glaziou 16353* (F, NY, US); São Cristovao, Rio de Janeiro, *Glaziou 6842* (RB); without locality, *Glaziou 17223* (K, MO, NY); without locality, *Glaziou 17243* (F); without locality, *Glaziou 17273* (US); without locality, *Glaziou 18509* (G, GH, NY).

Common names. Brazil: Pau branco, vareteiro.

Two sheets at Kew are potential types of *Phyllostylon brasiliense*. One has a small sprig with several leaves and no flowers. Beneath it is written: "*Phyllostylon guanabarense*. Rio, Brazil, near the Sea. Nov. gen. of Prof. Capanema in Ulmaceae." The handwriting perhaps is that of J. D. Hooker, but does not exactly match the handwriting samples I examined (Candollea 30: 397-398. 1975). The other is a full sheet of flowering branches without any leaves. On the lower left of the sheet is written: "(bis) *Phyllostylon brasiliense*, Capa. Comm. for Capanema 1/77." Correspondence from G. S. Capanema to J. D. Hooker not only illuminates the discovery of this new genus but also provides information to determine which specimen is best identified as the type. Excerpts from several letters from Prof. G. S. de Capanema follow.

London, March [?] 1856

Dear Sir,

On my way home to Brazil, I'll take the liberty to call upon you for some moments after tomorrow if you are not very occupied that day. I would be very glad to see the Ulmaceous[?]

tribe in your herbarium. I found in Rio Janeiro a plant believe [?] going to that family, which I suppose new, but remarquable [sic] for growing in the tropics.

Your most faithful and
obedient servant,
Prof. G. S. de Capanema

London March 5th 1856

Herewith I have the pleasure to send you two samples of aromcaria wood, a small portion of Lycanin (?), and a branchlet of the brazilian ulmacea which I called *Phyllostylon guanabarense* arriving in Brazil I'll procure you better and more complete sample.

London 18th March 1856

If our ulmacea flourishes this year (in August) you shall have complete samples otherwise only leaves till better occasion.

Rio Janeiro, July 12th 1856.

I enclose also two small branches of my *Phyllostylon* with leaves, one I had in my herbarium lost all its flowers...

Rio Janeiro, November 28, 1876

I profit the opportunity of Major Richard Severs going home to send you a specimen of *Phyllostyllon brasiliense*. I changed the specific name because I found it very common at Crato [Ceara], where it is called Paobranco—different of the tree bearing the [?] name at the coast—a Córdia in the provinces of Rio Janeiro and Espirito Santo. It is an Ulmus in habit inflorescence & with [?] fruit—and the only capital difference is radicule nifera—unfortunately I was absent and no fruit was collected, it ripening in a very short time.

It is the above specimen that Capanema refers to that appears to be the holotype. This sheet is annotated in Hooker's handwriting: "(bis) *Phyllostylon brasiliense* Capa. Com. for Capanema 1/77."

Phyllostylon brasiliense is morphologically and geographically distinct from *P. rhamnoides*. In addition to the characters listed in the key, *P. brasiliense* is further distinguished from *P. rhamnoides* by having chartaceous (vs. coriaceous) leaves that are densely puberulent beneath (vs. glabrous to sparsely puberulent) and dry glabrous to sparsely scabrous (vs. leaves drying very scabrous). Furthermore, the teeth usually begin 1/3 the distance from the base of the lamina (vs. 1/2 the distance from the base of the lamina) and have deep sinuses with the lower side of sinus (the apical side of the tooth) convex (vs. concave).

2. **Phyllostylon rhamnoides** (Poisson) Taubert, Oesterr. Bot. Z. 11:409. 1890.

Samaroceltis rhamnoides Poisson, Compt. Rend. Assoc. Franc. avanc. sci. 16ième sess., 2:595. 1888. TYPE. PARAGUAY: Asunción, Oct 1875, *Balansa 2054* (HOLOTYPE: P!; ISOTYPE: K!).
Phyllostylum orthopterum Hallier, Meded. Rijks-Herb. 27:70. 1915. TYPE. BOLIVIA: Häufiger Baum in Wald um Charagua, 800 m, Dec 1910, *Herzog 1208* (HOLOTYPE: L!).

Trees or shrubs 4 – 20 m tall, with stiff irregular branches; bark gray, rough, falling off in small plates; trunk irregular, ribbed; larger stems glabrous, bright

green when fresh, drying gray; younger stems light reddish brown, often puberulent. Leaves elliptic, ovate to broadly ovate, (0.7-)1.2 – 4.3(-5.1) × 0.4 – 2(-3.8) cm, acute, retuse or obtuse at apex, round to subcordate at base, margin entire or serrate with 1 – 10(-15) teeth on each side usually only in the upper 1/2 of lamina, asperous, with dense white dots, puberulent along veins with white hairs beneath, lateral veins raised below, tertiary venation drying dark beneath; petioles 1 – 4(-5) mm long, puberulent; stipules small, lanceolate, 4 – 5 mm long, puberulent, caducous. Inflorescences fascicles borne in the leaf axils, usually appearing after the leaves have fallen, lower flowers staminate, upper flowers bisexual. Flowers borne on short peduncles 3 – 5 mm long; sepals 5 – 6, lanceolate, ca. 3 mm long, densely puberulent; stamens 5, filaments 1 – 1.5 mm long; staminate flowers with or without pistillode; perfect flowers with a compressed sessile ovary, the two style branches unequal. Fruit a samara 2.5 – 4.0 × 7.5 – 13 cm with two membranaceous wings; the enlarged seed cavity irregularly ribbed, puberulent; the larger wing 1.7 – 2.7 cm long, 0.7 – 1.5 cm broad, elliptic to narrowly cuneate, rounded to acute at apex, the dorsal edge usually curved, sometimes straight, the smaller wing (4-)7 – 10 mm long, narrow and curved inward.

Common names. Mexico: cerón, coanextle. Dominican Republic: baitoa. Colombia: varoblanco, sabanemico. Argentina: palo blanco, palo amarillo, palo de Lauza.

Distribution (Fig. 1). Tamaulipas, Mexico to Nicaragua, Cuba, Haiti, the Dominican Republic, Venezuela, Colombia, Bolivia, Paraguay, Argentina, and the planalto of Brazil.

Habitat and phenology. Because *Phyllostylon rhamnoides* is so broadly ranging it occupies a variety of habitat types although all within the dry tropical forest zone. In Mexico, Central America and the West Indies it occurs in scrub forest and thorn scrub forests often on calcereous soils and on brushy, rocky soils. In South America it is noted to occur in moist lowland forest and open savannas and in woods on clay soil. In Mexico and Central America flowering specimens are recorded for May and fruiting specimens have been collected in May, June and July. In the West Indies flowering specimens have been collected in February and fruiting has been recorded in January, February, March, April, and May. In northern South America fruiting occurs in February, March and May. No flowering specimens have been seen from Venezuela or Colombia. In southern South America flowering specimens are recorded in August, September and October with fruiting specimens from September through December.

Representative specimens examined. MEXICO. **Jalisco:** Mpio. La Huerta, Rancho Cuixmala, along road from Cumbres 1 to Cumbres 2, ca. 200 m below La Cuesta, 19°26'N, 104° 58'W, ca. 100 m, 13 May 1991, *Lott et al. 3520* (UCR). **Puebla:** Mpio. de Piaxtla, Rancho de Animas, carretera Puebla-Tlapa, Guererro, cerca del pueblo de Piaxtla, 1090 m, 20 Apr 1978, *Huerta et al. s.n.* (NY). **Queretaro:** Cerca de Concá, 650 m, 8 Apr 1971, *Rzedowski 28106* (TEX). **San Luis**

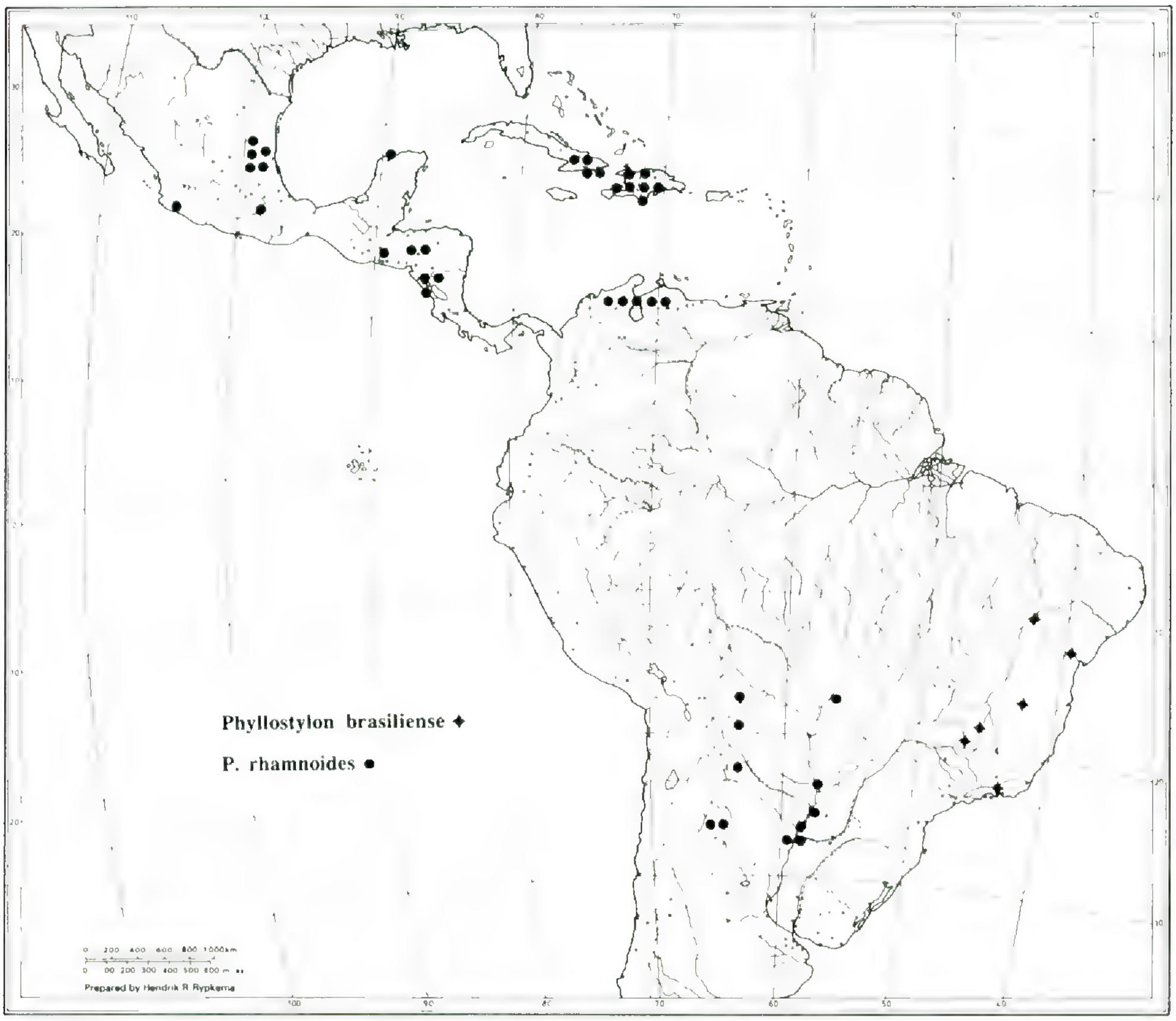

Fig. 1. Map showing distribution of *Phyllostylon brasiliense* and *P. rhamnoides*.

Potosi: Mpio. San Antonio, San Pedro, 26 Oct 1978, *Alcorn 2093* (TEX); 11 mi S of Tamuin on road to San Vicente or Tancuatalab, 1 May 1960, *Johnston & Crutchfield 5299-II*; Rancho "Casas Blancas," Plantaciones de Fibracel S.A., 60 m, 27 Oct 1967, *Pennington & Sarukhán 9308* (K, NY); Las Palmas, 5 Jul 1896, *Pringle 7290* (GH). **Tamaulipas:** 16 mi by road S of Victoria (7 mi N of the Tropic of Cancer, 1000 ft, 15 Nov 1959, *Johnston & Graham 4718* (TEX); 15 mi W of Gonzales toward Mante, 650 ft, 10 Dec 1959, *Johnston 4930C* (TEX); 18 mi S of San Carlos on the road to Padilla, 900 ft, 13 Dec 1959, *Johnston & Crutchfield 4994* (TEX); 2 mi north of Rio Guayalejo crossing on the Mante-Victoria Hwy, 3 May 1960, *Johnston & Crutchfield 5421* (TEX). **Veracruz:** Carretera Panuco-Tampico, 8 km depués de Panuco, 13 Aug 1970, *Chiang 59* (GH). **Yucatán:** Ruins of Dzibilchaltun, 12 km N of Mérida, ca. 20 m alt., *Gentry & Zardini 48862* (MO).

GUATEMALA. **Zacapa:** near divide along road between Zacapa and Chiquimula, 500 – 660 m, 9 Oct 1940, *Standley 73795* (NY, US); along road between Agua Blanca and Cumbre de Chiquimula, 350 – 500 m, 15 Oct 1940, *Standley 74433* (US).

HONDURAS. **Comayagua:** Valle Comayagua entre km 93 – 96 de Palmerola, 600 m, 27 Jun 1964, *Molina 14352* (NY, US); 5 km NW of Comayagua, 22 May 1972, *Clewell 3088* (MO). **Olancho:** between Juticalpa and El Asilo, 380 – 400 m, 10 Mar 1949, *Standley 17784* (US).

NICARAGUA. **Boaco:** Road to Boaquito, Hacienda San Antonio, 200 m, *Moreno & Robleto 22819* (MO). **Carazo:** ca. 7 km SE of La Trinadad, 100 – 200 m, *Grijalva 2655* (MO); between Amayito and Barranco Bayo, 30 – 100 m, *Stevens 22768* (MO). **León:** Cerro Montoso, NW de Volcán Momotombo, 300 – 450 m, *Sandino & Robleto 4425* (MO). **Managua:** Rancho Grande,

N of Río Racora, 80 – 90 m, *Araquistain 3512* (MO); along new road from Hwy 1 to San Francisco del Carnicero, 26 Nov 1978, *Stevens 10987* (MO). **Matagalpa:** Presa Santa Bárbara, San Juan de Dios, 200 m, *Moreno 21586* (MO); Carretera Panamericana Norte, N of Cuesta del Venado, 450 m, 25 Mar 1984, *Stevens 22888* (MO, TEX).

CUBA. **Oriente:** United States Naval Station, Guantanamo Bay, 17 – 30 Mar 1909, *Britton 1968* (NY-2 sheets); vic. of Daiquiri, 14 – 16 Mar 1912, *Britton & Cowell 12642* (NY); vic. of Daiquiri, *Britton & Cowell 12653* (NY, US); Ensenada de Mora, 26 – 29 Mar 1912, *Britton et al. 12922* (MO, US); Bayate, on the Canto bank, 10 Feb 1915, *Ekman 4596* (G, NY); Salbis, at the border with prov. Camaguey, 14 Aug 1916, *Ekman 7446* (NY); Papayo, 2 Feb 1919, *Ekman 9467* (G, K, NY, US); Sierra Maestra, *Lopéz 2991* (US).

HAITI. **Nord-Ouest:** Vic. of Port de Paix, *Leonard & Leonard 11071* (US); Tortue Island, vic. of La Vallée, *Leonard & Leonard 11517* (US); vic. of Bassin Bleu, banks of Les Trois Rivières, road to Gros Morne, 630 – 1500 m, 15 Apr 1929, *Leonard & Leonard 14663* (GH, NY, US). **L'Artibonite:** Vic. of Étroite, Gonave Island, 15 – 21 Mar 1920, *Leonard 3358* (NY, US); vic. of Gros Morne, 235 m, 19 Feb 1926, *Leonard 10004* (NY, US); ca. 5 – 7 km Oeste de Gonaïves en la carretera costera a Anse Rouge, 19°27' N, 72°49' W, 15 m, 21 Oct 1983, *Zanoni et al. 27669* (JBSD).

DOMINICAN REPUBLIC. **Azua:** Loma Vieja, 80 m, 12 Mar 1980, *Mejía 169* (JBSD, NY); without locality, Mar 1913, *Rose et al. 3872* (NY, US); *Rose et al. 4409* (NY, US). **Barahona:** near town of Las Salinas, 16 Aug 1946, *Howard & Howard 8373* (A, NY). **Monti Cristi:** 1.5 km N of Rincón, 19°50'N, 71°37'W, 50 – 60 m, 17 Aug 1984, *García & Alba 182* (JBSD); Reserva Científica "Dr. Orlando Cruz Franco," 8 km N of Villa Elisa, 19°44'N, 71°15.5'W, 120 m, 21 Aug 1985, *Pimentel & García 506* (JBSD). **Pedernales:** Bahoruco Peninsula, 5 km on road to Las Mercedes from road to Pedernales, 60 m, Jul 1981, *Fisher-Meerow 573* (JBSD); Recta de Sauson, 16 km NW of Oviedo, 160 m, 12 Apr 1985, *Gentry & Mejía 50742* (MO); Loma El Guano, 200 m, 12 Apr 1985, *Gentry & Mejía 50755* (MO).

VENEZUELA. **Falcon:** Dtto. Buchivacoa, 31 km S of Dabajuro, 200 m, 17 Jun 1978, *Bunting et al. 6439* (MO). **Lara:** desert between Carora and Barquisimeto, 500 m, 28 May 1944, *Steyermark 56828* (NY). **Zulia:** Dtto. Maracaibo, carretera Perijá, entre Maracaibo y La Villa del Rosario, en km 24 de la vía, 5 Mar 1978, *Aristeguieta & Ferrer 12542* (MO); Dtto. Maracaibo, carretera Maracaibo-Machiques, en km 21 al SO de Maracaibo, 100 m, 4 May 1978, *Bunting & Ferrer 6276A* (MO); Dtto. Maracaibo, carretera La Concepción-Cuatro Bocas, en km 13 al norte de La Concepción, o sea 1 km al sur de la encrucijada con la carretera Puerto Caballo-Cachirí, 1 Aug 1978, *Bunting 6586* (MO); Dtto. Miranda, rd. between the Lara-Zulia and Coro-Maracaibo Hwys, 4 Mar 1979, *Bunting 7182* (MO); Dtto. Bolívar, Parque Yaguasa, 0 – 25 m, 24 Sep 1979, *Bunting & Galué 7938* (MO); espinares a lo largo de la carretera hacia Villa de Rosario, 18 – 22 km oeste-suroeste de Maracaibo, 100 m, 21 Aug 1967, *Steyermark & Fernández 99532* (NY).

COLOMBIA. **Guajira:** 2 leguas al oeste de Villanueva, 20 Feb 1966, *Ferreria 2* (NY). **Magdalena:** Valle del Río Cesare (parte occidental, cerca del Caño Sagarriga, al oeste de Los Venados) 10°N, 73°45'W, 70 m, 21 – 22 Jan 1961, *Dugand 551* (US); same locality, *Dugand 5588* (US); same locality, 20 Apr 1963, *Dugand 6287*; same locality, 21 Apr 1963, *Dugand 6291* (NY, US).

BOLIVIA. **Santa Cruz:** Prov. Andres Ibanez, Jardin Botanico de Santa Cruz, 12 km E of center of Santa Cruz on road to Cotoca, 17°46'S, 63°04'W, 375 m, 27 Sep 1990, *Nee 38926* (TEX).

BRAZIL. **Mato Grosso:** Road to Santa Isabel from Jofre, 56°55'W, 17°7'S, 13 Jun 1979, *Prance et al. 26179* (NY).

PARAGUAY. **Central:** In the region of lake Ypacaray, Sep 1913, *Hassler 12302* (A, G, GH, MO, NY, US); *Hassler 12677* (G, GH, K, MO, NY, US). **Concepción:** Prope Concepción, Aug 1902, *Hassler 7280* (A, G, K, MO, NY). **Paraguarí:** Costa, Cerro Palacios, 30 Oct 1987, *Besualdo & Zardini 1317* (TEX).

ARGENTINA. **Chaco:** Vic. of Barranqueras, 35 – 40 m, 12 Nov-Dec 15, 1913, *Curran 382* (NY, US); Fontana, Oct 1932, *Meyer 721* (GH); Colonia Benítez, 3 Aug 1967, *Schulz 15993* (MO). **Corrientes:** Dept. Empedrado, Estancia "La Yela," 30 Aug 1954, *Pederson 2793* (G, MO, NY, US); same locality, 2 Nov 1954, *Pedersen 2793a* (G, K, MO, NY, US); Dept. Capital, camino a Perichón, 11 Oct 1984, *Schinini & Cuadrado 25012* (G). **Formosa:** near Formosa, Sep 1918, *Jórgensen 3044* (MO, US); Dept. Pilocomayo, Paraíso, 8 Oct 1948, *Morel 6164* (GH, US). **Salta:** Orán, Río Piedras, 4 Dec 1911, *Rodriguez 164* (A, GH)); Dept. Orán, Tartagal, Picadas de las Cañas, 700 m, 29 Nov 1924, *Schreiter 3328* (ECON); Orán, 750 m, 12 Nov 1927, *Venturi 5547* (A, GH, K, MO). **Tucuman:** Dept. Capital, Capital, 430 m, Oct 1941, *Meyer 3924* (BRIT/SMU, GH, LL, MO, NY, TEX, US); Dept. Burruyacú, Cañada Larga, 19 Sep 1922, *Venturi 1907* (A, US).

Phyllostylon rhamnoides is morphologically quite stable throughout its range, even across its wide disjunction from northern Venezuela (10° N latitude) to central Brazil (17° S latitude). Its rounded to acute, retuse or obtuse leaf apices, dentations only in the upper half of the lamina distinguish it from *P. brasiliense*.

In the past *Phylostylon rhamnoides* has been placed into synonymy under *P. brasiliense*, the earliest name in the genus. However, specimens from coastal Brazil are clearly distinguishable from the populations from the rest of South America, Central America, and the West Indies, by the characters listed in the key and discussed under the latter species.

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STRUCTURE, DISTRIBUTION AND TAXONOMIC IMPORTANCE OF TRICHOMES IN *TEPHROSIA* (FABACEAE)

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ABSTRACT

Structure, organographic distribution and taxonomic importance of trichomes in sixteen species of *Tephrosia* Pers. are described for the first time based on LM and SEM studies. Trichomes are either unicellular or multicellular and categorized into unicellular, uniseriate filiform and uniseriate macroform. Taxonomic utility of stylar trichiferous condition in *Tephrosia* is emphasized once again in the Indian context. The taxonomic significance and circumscription of *Tephrosia* in relation to other genera within tribe Galegeae are discussed based on the distribution of trichomes. A key is presented to delimit the sixteen species studied utilizing organographic distribution of trichome types.

INTRODUCTION

Trichomes offer more valuable taxonomic information than all the other epidermal elements because of their diversity in structure as well as distribution (Stace 1989; Shanmukha Rao 1991). In *Tephrosia* Pers., the earlier data has been related primarily to stomata, not to trichomes (Shah & Gopal 1969; Shah et al. 1975; Shah & Kothari 1976; Bhatt & Tuteja 1984). Therefore, the objective is to describe the structure, organographic distribution, and taxonomic importance of trichome types in sixteen species of *Tephrosia* based upon Light Microscopic (LM) and Scanning Electron Microscopic (SEM) studies.

MATERIALS AND METHODS

The details of the 16 species investigated are presented in Table 1. Of these, *T. barberi*, *T. canarensis*, *T. roxburghiana* and *T. wynaadensis* are rare, endangered and little known endemics of South India (Nair & Henry 1983).

LM study: Trichomes were studied from epidermal peelings obtained by scrapping the young and mature parts. Boiling herbarium specimens in dilute nitric acid was found necessary. Petals and stamens however, were directly

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TABLE 1. List of *Tephrosia* species investigated.

S. No. Name of the species	Locality/Source of material	Nature
1. *T. barberi* Drumm.	BSI, SC, Coimbatore	HM
2. *T. canarensis* Drumm.	BSI, SC, Coimbatore	HM
3. *T. candida* (Rob.) DC	BSI, SC, Coimbatore	HM
4. *T. hamiltonii* Drumm.	Hyderabad, AP	FM
5. *T. hookeriana* Wt. & Arn.	BSI, SC, Coimbatore	HM
6. *T. maxima* (L.) Pers.	Hyderabad, AP	FM
7. *T. pulcherrima* (Wt. ex Baker) Drumm.	BSI, SC, Coimbatore	HM
8. *T. pumila* (Lam.) Pers.	Hyderabad, AP	FM
9. *T. purpurea* (L.) Pers.	Hyderabad, AP	FM
10. *T. roxburghiana* Drumm.	BSI, SC, Coimbatore	HM
11. *T. spinosa* (L.) Pers.	Warangal, AP	FM
12. *T. strigosa* (Dalz.) Santapau & Mahesh.	Hyderabad, AP	FM
13. *T. tinctoria* Pers.	Tirupati, AP	FM
14. *T. villosa* (L.) Pers.	Hyderabad, AP	FM
15. *T. vogelii* Hoof. f.	BSI, SC, Coimbatore	HM
16. *T. wynaadensis* Drumm.	BSI, SC, Coimbatore	HM

AP = Andhra Pradesh, India; BSI = Botanical Survey of India;
FM = Fresh material; HM = Herbarium material; SC – Southern Circle

mounted as such. The micropreparations were then stained with safranin and mounted in 80% glycerin.

SEM study: Plant parts were cut into small pieces and mounted on brass stubs. Then they were coated with gold at 1.2 kV under high vacuum and observed under a JEOL JSM -35 Scanning Electron Microscope at a constant power supply of 20 kV.

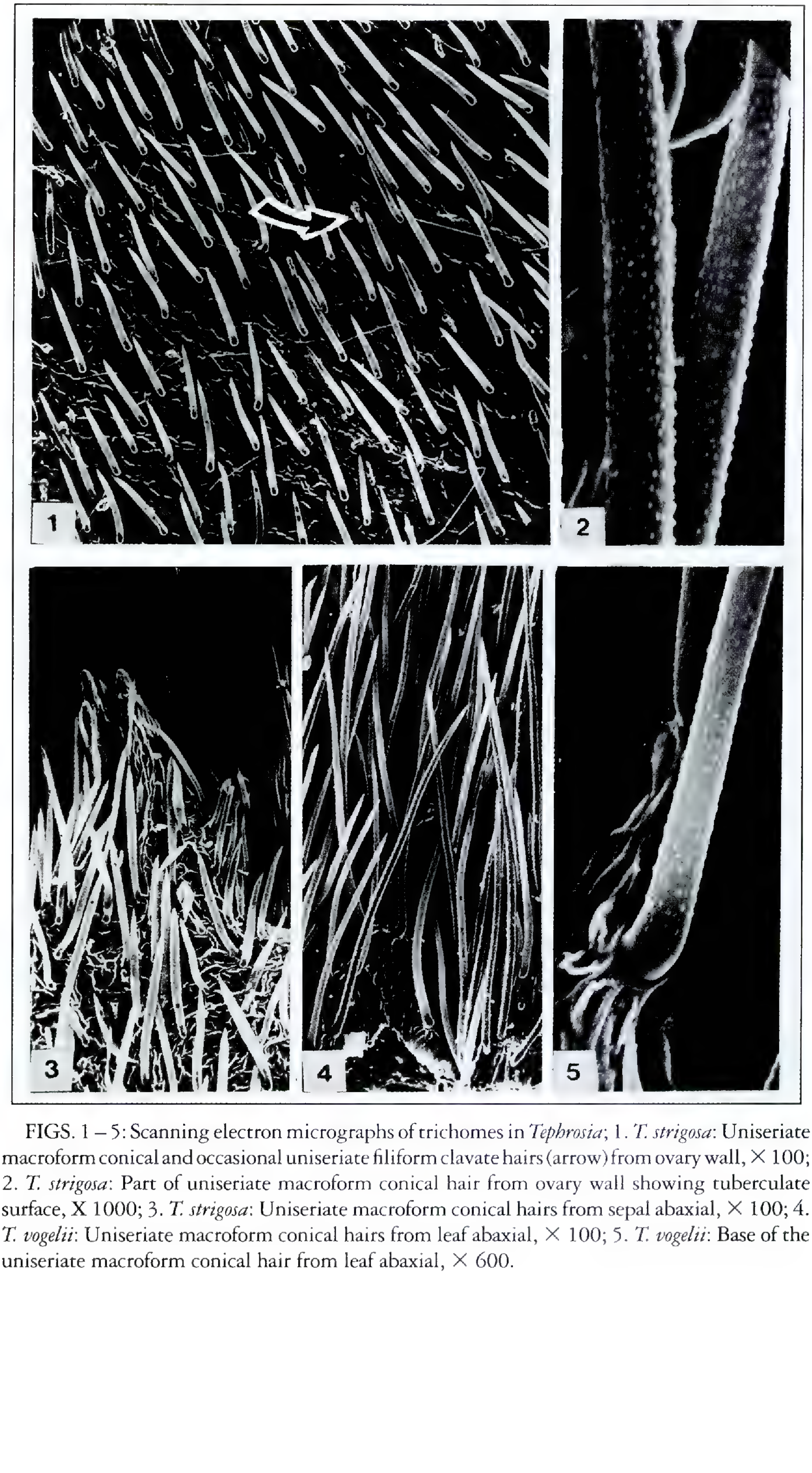
The data presented were mainly based on LM studies and SEM data supplements the observations made on LM, especially to understand surface ornamentation of trichomes. The sample includes five specimens in each species excepting for two specimens in case of rare material. The voucher specimens were deposited in the Department of Botany, Sardar Patel College, Secunderabad, India.

Terminology: Each trichome basically consists of two parts, the foot and the body (Ramayya 1981). The former is mostly embedded in the epidermis while the latter constitutes the emergent part. The body may be entire or often in many trichome types shows further differentiation into a stalk and a head.

OBSERVATIONS

Three trichome types could be recognized in the species studied. Structural details are presented below.

1. **Unicellular papillate hair:** Foot: Indistinct from the body, embedded in the epidermis; wall thin, contents scanty. Body: Represented by a slight



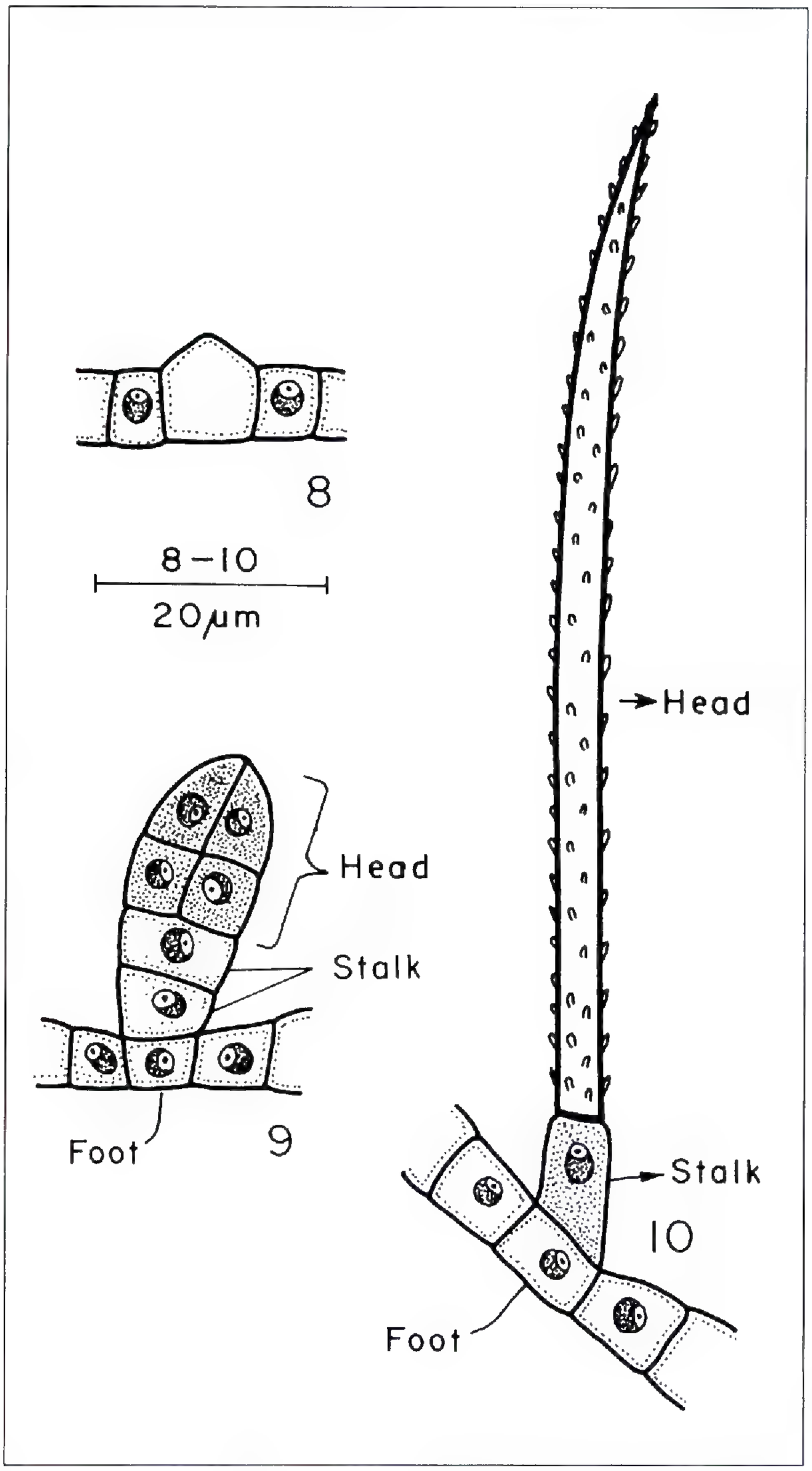
FIGS. 1 – 5: Scanning electron micrographs of trichomes in *Tephrosia*; 1. *T. strigosa*: Uniseriate macroform conical and occasional uniseriate filiform clavate hairs (arrow) from ovary wall, × 100; 2. *T. strigosa*: Part of uniseriate macroform conical hair from ovary wall showing tuberculate surface, X 1000; 3. *T. strigosa*: Uniseriate macroform conical hairs from sepal abaxial, × 100; 4. *T. vogelii*: Uniseriate macroform conical hairs from leaf abaxial, × 100; 5. *T. vogelii*: Base of the uniseriate macroform conical hair from leaf abaxial, × 600.

FIGS. 6–7: 6. *T. hamiltonii*: Uniseriate macroform conical hairs and uniseriate filiform clavate hairs (arrow) from the stem, × 360; 7. *T. barberi*: Uniseriate macroform conical hairs from rachis, × 80.

projection above epidermis, inconspicuous in surface view; papillate, apically acute or slightly obtuse; wall thin, surface smooth, contents scanty (Fig. 8).

2. **Uniseriate filiform clavate hair:** Foot: One celled, projected slightly above the epidermis; wall thin, contents scanty. Stalk: Uniseriate, cylindrical, 1 – 3 celled, cells usually broader than long; cross walls straight and thin, lateral walls thin, surface smooth, contents dense. Head: Clavate, uni-, bi-, or multiseriate, 1 – 3 tiered with 2 – 4 cells per tier, cells usually broader than long; walls thin, surface smooth, contents dense (Figs. 1, 6, 9).

3. **Uniseriate macroform conical hair:** Foot: One celled, bulbous, projected slightly above the epidermis, base rounded; wall thick, contents scanty. Stalk: One celled; wall thin, contents scanty. Head: One celled, elongate, length variable, apex acute; walls thick, surface tuberculate, granulate or smooth, contents absent (Figs. 1 – 7, 10).



FIGS. 8–10: 8. *T. strigosa*: Unicellular papillate hair from standard petal adaxial; 9. *T. maxima*: Uniseriate filiform clavate hair from sepal abaxial; 10. *T. maxima*: Uniseriate macroform conical hair from sepal abaxial.

KEY FOR THE IDENTIFICATION OF HAIR TYPES IN *TEPHROSIA*

1. Hair unicellular ..... *Unicellular papillate hair*
1. Hair multicellular and uniseriate.
   2. Hair macroform and conical; consists of foot and body; body differentiated into one celled proximal stalk and one celled conical head which is dead at maturity ..... *Uniseriate macroform conical hair*
   2. Hair filiform and clavate; consists of foot and body; body further differentiated into a proximal stalk and a distal clavate head ..... *Uniseriate filiform clavate hair*

The data for organographic distribution of trichomes encountered on the vegetative parts are presented in Table 2 and on the floral parts in Table 3.

DISCUSSION

a) Structure

The trichome types reported earlier in the Papilionoideae are either unicellular (Leelavathi & Ramayya 1983; Vijay Kumar 1988) or multicellular (Solereder 1908; Sabnis 1920; Metcalfe & Chalk 1950; Shah & Kothari 1973, 1975; Kothari & Shah 1974, 1975; Lackey 1981; Leelavathi & Ramayya 1983; Vijay Kumar 1988). The multicellular trichomes in *Tephrosia* are uniseriate exclusively whereas biseriate and multiseriate trichome categories, though reported earlier in the Papilionoideae (Leelavathi & Ramayya 1983; Vijay Kumar 1988) are totally absent in *Tephrosia*. Further, it appears that the ubiquitous presence of unicellular and uniseriate trichome categories and absence of biseriate and multiseriate ones in *Tephrosia* is interesting and taxonomically significant. This taxon stands apart from other genera of tribe Galegeae as the latter possess biseriate and multiseriate trichome categories in addition to unicellular and uniseriate ones (Prabhakar et al. 1985; Vijay Kumar 1988). This stresses the need to probe further into distributional aspects of trichomes at intergeneric level in the tribe Galegeae vis-a-vis their taxonomic circumscription.

Trichomes in *Tephrosia* possess a simple foot that is projected slightly above the epidermis. The body of the trichome is entire in unicellular papillate hairs whereas in uniseriate ones, it exhibits a stalk and a head. The uniseriate macroform conical hair, also referred to as the 'ordinary simple papilionaceous hair' or '3-celled hair' by Solereder (1908) and Metcalfe & Chalk (1950) respectively, invariably consists of only 3 cells including the foot cell (except in *T. strigosa*, where the hair is mostly 2-celled) with two shorter proximal cells and a very long distal cell (Fig. 10).

The wall of uniseriate macroform conical hair is thick whereas it is thin in unicellular papillate and uniseriate filiform clavate hairs. The surface is smooth in unicellular papillate and uniseriate filiform clavate hair types whereas in uniseriate macroform conical hair, the head is tuberculate (Figs. 2, 5) in all the plant parts except on the petal where it is smooth under LM but granulate under SEM.

TABLE 2. Organographic distribution of trichome types in the vegetative parts in *Tephrosia* Pers.

S. No. Name of the species	Leaf			Rachis/Petiolule Petiole		Stipule			Stem
	Ab	Ad	M			Ab	Ad	M	
1. *T. barberi*	B,C	B,C	B,C	B,C	B,C	B,C	B,C	B,C	B,C
2. *T. canarensis*	B,C	C	B,C	B,C	B,C	C	–	B,C	B,C
3. *T. candida*	B,C	B,C	B,C	B,C	B,C	B,C	–	B,C	B,C
4. *T. hamiltonii*	B,C	B,C	B,C	B,C	B,C	B,C	B,C	B,C	B,C
5. *T. hookeriana*	B,C	B,C	B,C	B,C	B,C	B,C	B,C	B,C	B,C
6. *T. maxima*	B,C	B,C	B,C	B,C	B,C	B,C	B,C	B,C	B,C
7. *T. pulcherrima*	A,B,C	C	B,C	B,C	B,C	B,C	–	B,C	A,B,C
8. *T. pumila*	B,C	B,C	B,C	B,C	B,C	B,C	–	B,C	B,C
9. *T. purpurea*	B,C	B,C	B,C	B,C	B,C	B,C	B,C	B,C	B,C
10. *T. roxburghiana*	C	C	B,C	B,C	B,C	B,C	B,C	B,C	B,C
11. *T. spinosa*	B,C	B,C	B,C	B,C	B,C	C*	C*	C*	B,C
12. *T. strigosa*	B,C	B,C	B,C	B,C	**	B,C	–	B,C	B,C
13. *T. tinctoria*	B,C	–	B,C	B,C	B,C	B,C	–	B,C	B,C
14. *T. villosa*	B,C	B,C	B,C	B,C	B,C	B,C	–	B,C	B,C
15. *T. vogelii*	B,C	B,C	B,C	B,C	B,C	B,C	–	B,C	B,C
16. *T. wynaadensis*	B,C	B,C	B,C	B,C	B,C	B,C	–	B,C	B,C

A = Unicellular papillate hair; B = Uniseriate filiform clavate hair; C = Uniseriate macroform conical hair; – = Trichomes absent; ** = Part absent; * = Modified into a spine; Ab = Abaxial; Ad = Adaxial; M = Margin.

TABLE 3. Organographic distribution of trichome types in the floral parts in *Tephrosia* Pers.

S. No.	Name of the species	Peduncle/ Pedicel	Bract			Sepal			Standard petal			Wing petal			Keel petal			Stamen	Ovary	Style
			Ab	Ad	M	Ab	Ad	M	Ab	Ad	M	Ab	Ad	M	Ab	Ad	M			
1.	*T. barberi*	B,C	B,C	B,C	B,C	B,C	B,C	B,C	C	A	C	C	A	–	–	–	A	–	B,C	–
2.	*T. canarensis*	B,C	B,C	–	B,C	B,C	–	B,C	C	A	B,C	–	A	–	–	–	A	–	B,C	C
3.	*T. candida*	B,C	B,C	–	B,C	B,C	–	B,C	C	A	C	–	A	–	–	–	A	–	C	C
4.	*T. hamiltonii*	B,C	B,C	B,C	B,C	B,C	B,C	B,C	C	A	C	C	A	–	–	–	A	–	C	–
5.	*T. hookeriana*	B,C	B,C	B,C	B,C	B,C	B,C	B,C	C	A	C	–	A	–	C	–	A	–	C	–
6.	*T. maxima*	B,C	B,C	–	B,C	B,C	B,C	B,C	B,C	A	B,C	–	A	–	C	–	A	–	B,C	B,C
7.	*T. pulcherrima*	B,C	B,C	-	B,C	B,C	–	B,C	C	A	C	C	A	–	C	–	A	–	C	C
8.	*T. pumila*	B,C	B,C	–	B,C	B,C	–	B,C	C	A	C	–	A	–	–	A	A	–	B,C	–
9.	*T. purpurea*	B,C	B,C	B,C	B,C	B,C	B,C	B,C	C	A	C	–	A	–	C	–	A,C	–	C	–
10.	*T. roxburghiana*	B,C	B,C	–	B,C	B,C	–	B,C	C	A	C		A	–	–	–	A		C	C
11.	*T. spinosa*	B,C	B,C	–	B,C	B,C	–	B,C	C	A	A,C	–	A	–	–	A	A	–	C	–
12.	*T. strigosa*	B,C	B,C	–	B,C	B,C	–	B,C	C	A	C	–	A	–	–	A	A	–	B,C	–
13.	*T. tinctoria*	B,C	B,C	–	B,C	B,C	–	B,C	C	A	C	–	A	–	–	–	A	–	C	C
14.	*T. villosa*	B,C	B,C	–	B,C	B,C	C	B,C	C	A	C	–	A	–	C	–	A	–	C	–
15.	*T. vogelii*	B,C	B,C	–	B,C	B,C	B,C	B,C	B,C	A,C	B,C	–	A	C	C	–	A	–	B,C	C
16.	*T. wynaadensis*	B,C	B,C	C	B,C	B,C	–	B,C	B,C	A	B,C	–	A	–	–	A	A	–	C	C

A – Unicellular papillate hair; B = Uniseriate filiform clavate hair; C = Uniseriate macroform conical hair; – – Trichomes absent; Ab – Abaxial; Ad Adaxial; M – Margin.

b) Distribution

All the vegetative as well as floral parts excluding the stamens are frequently trichiferous in *Tephrosia* presently studied. However, stamens are trichiferous towards their proximal ends in some *Tephrosia* occurring in Malesia (Bosman & de Haas 1983). In comparison, none of the Indian taxa studied exhibited hairy stamens.

The presence of papillate condition in the floral parts of many angiosperms is a common feature, being an adaptation for insects to land during pollination. This condition is confirmed on the adaxial surfaces of standard and wing petals as they possess unicellular papillate hairs uniformly in all taxa studied. However, keel petals possess these hairs on their adaxial surface in only four taxa, viz. *T. pumila*, *T. spinosa*, *T. strigosa* and *T. wynaadensis* (Table 3). This rare occurrence is probably because keel petals are folded and their adaxial surfaces are not completely exposed. However, the outer margins of keel petals in all the taxa studied possess these hairs.

The presence of papillose lower epidermis of the leaf has been reported in many taxa of Leguminosae, but not in *Tephrosia* (Solereder 1908; Metcalfe & Chalk 1950). Presently, this condition with occasional unicellular papillate hairs is observed on the leaf's abaxial surface only in *T. pulcherrima* and hence this taxon stands apart from the rest. The abaxial surface in the leaf, stipule, bract and sepal, including the margins, is trichiferous in the taxa studied (Fig. 3). The trichomes form a dense covering on the leaf's abaxial surface, sometimes making it even difficult to observe epidermal cells and stomata in *T. barberi*, *T. canarensis*, *T. candida*, *T. hookeriana*, *T. pulcherrima*, *T. roxburghiana*, *T. tinctoria*, *T. vogelii* (Fig. 4) and *T. wynaadensis.*

The adaxial surface presents a slightly different picture in comparison with the abaxial surface of the laminar parts. The leaf's adaxial surface is trichiferous in all taxa studied excepting *Tephrosia tinctoria*, whereas the stipule's adaxial surface is trichiferous in *T. barberi*, *T. hamiltonii*, *T. hookeriana*, *T. maxima*, *T. purpurea* and *T. roxburghiana* (Table 2). However, the bract's adaxial surface is trichiferous only in *T. barberi*, *T. hamiltonii*, *T. hookeriana*, *T. purpurea* and *T. wynaadensis* and the sepal's adaxial surface in *T. barberi*, *T. hamiltonii*, *T. hookeriana*, *T. maxima*, *T. purpurea*, *T. villosa* and *T. vogelii* (Table 3).

Distribution of trichomes among different petals in *Tephrosia* is interesting. The standard petal alone exhibits a conspicuous presence of multicellular trichomes compared to the wing and keel petals. The abaxial surface of the standard petal is characterized by uniseriate macroform conical hairs in all taxa. However, their distribution pattern is unique. The standard petal is orbicular with an obtuse to emarginate apex. It consists of a claw and a limb. The trichomes are absent on the claw, the lower middle part of the limb and proximal margins. Interspersed with uniseriate macroform conical hairs are uniseriate filiform

clavate hairs borne occasionally on the abaxial surface in *T. maxima*, *T. vogelii* and *T. wynaadensis*.

Uniseriate macroform conical hairs are absent on the adaxial surface of standard petals except in *Tephrosia vogelii* where these hairs are present in the distal half, thereby making it a distinct taxon. In addition, the margin of the standard petal possesses unicellular papillate hairs in *T. spinosa* and uniseriate filiform clavate hairs in *T. canarensis*, *T. maxima*, *T. vogelii* and *T. wynaadensis*.

The wing and keel petals in *Tephrosia* generally are devoid of multicellular hairs, but rarely uniseriate macroform conical hairs are seen on the wing petal's abaxial surface in *T. barberi*, *T. hamiltonii* and *T. pulcherrima*, on the wing petal's margin in *T. vogelii,* on the keel petal's abaxial surface in *T. hookeriana*, *T. maxima*, *T. pulcherrima*, *T. purpurea* and *T. villosa* and on the keel petal's margin in *T. purpurea*. However, these conical hairs are common in *T. vogelii* and dense along the joint of the keel petals on their abaxial surface.

The axiate vegetative parts (rachis/petiole, petiolule and stem) in *Tephrosia* are trichiferous, possessing both uniseriate filiform clavate and uniseriate macroform conical hairs. The peduncle and pedicel exhibit a similar trichome distribution in the respective species.

The ovary is covered by a dense clothing of the uniseriate macroform conical hairs. However, it also possesses the uniseriate filiform clavate hairs in *T. barberi*, *T. canarensis*, *T. maxima*, *T. pumila*, *T. strigosa* (Fig. 1) and *T. vogelii*.

c) Taxonomic Importance

Wood (1949) divided the New World species of *Tephrosia* into two groups, one with a glabrous style and the other with a pubescent style. Gillett (1959) adopted this classification in African species of *Tephrosia*. Subsequently, Brummitt (1981) divided the genus into two subgenera, subg. *Tephrosia* characterized by a glabrous style and subg. *Barbistyla* by a pubescent style. However, Bosman & de Haas (1983) in their revision of Malesian *Tephrosia* did not give importance to this distinction as the number of species in Malesia with pubescent style is limited. However, the style's pubescence is considered as an important character in delimiting Indian *Tephrosia*, as the pubescent style occurs in eight species viz. *T. canarensis*, *T. candida*, *T. maxima*, *T. pulcherrima*, *T. roxburghiana*, *T. tinctoria*, *T. vogelii* (an African sp. cultivated in India) and *T. wynaadensis*. Trichomes are present either throughout the distal half of the style or on only one side of that half. The trichome type involved is the uniseriate macroform conical hair except in *T. maxima* where uniseriate filiform clavate hairs also intermingle.

Bentham (1865) assigned *Tephrosia* to the tribe Galegeae along with 53 other genera that included *Astragalus*, *Cyamopsis*, *Glycyrrhiza*, *Gueldenstaedtia*, *Indigofera* and *Psoralea*. Polhill & Raven (1981) segregated the genera of Galegeae (sensu lato) and assigned these genera noted above into different tribes e.g. *Tephrosia* in tribe *Tephrosieae*, *Astragalus*, *Glycyrrhiza* and *Gueldenstaedtia* in Galegeae (sensu

stricto), *Cyamopsis* and *Indigofera* in Indigofereae and *Psoralea* in Psoraleae. Solereder (1908) and Metcalfe & Chalk (1950) recorded in the tribe Galegeae (sensu lato), 2-armed hairs in *Astragalus*, *Cyamopsis*, *Indigofera* and *Gueldenstaedtia*, hooked hairs in *Psoralea* and peltate hairs in *Glycyrrhiza*. These three types of hairs are conspicuously absent in *Tephrosia*. Hence, the placement of these genera mentioned above into different tribes by Polhill & Raven (1981) appears justified based upon the distribution of different trichome types.

This clearly demonstrates that trichome distribution in different genera of Galegeae (sensu lato) has taxonomic importance. Further studies in this area could certainly throw more light on the realignment and circumscription of the tribes of the Papilionoideae.

KEY TO TAXA STUDIED BASED MAINLY ON ORGANOGRAPHIC DISTRIBUTION OF TRICHOMES

1. Style trichiferous
   2. Trichomes absent on leaf's adaxial surface ..... *T. tinctoria*
   2. Trichomes present on leaf's adaxial surface
      3. Trichomes present on stipule's adaxial surface
         4. Uniseriate macroform conical hairs present on keel petal ..... *T. maxima*
         4. Uniseriate macroform conical hairs absent on keel petal ..... *T. roxburghiana*
      3. Trichomes absent on stipule's adaxial surface
         5. Uniseriate macroform conical hairs present on standard petal's adaxial surface ..... *T. vogelii*
         5. Uniseriate macroform conical hairs absent on standard petal's adaxial surface
            6. Unicellular papillate hairs present on vegetative parts (leaf abaxial and stem) ..... *T. pulcherrima*
            6. Unicellular papillate hairs absent on vegetative parts
               7. Uniseriate macroform conical hairs present on bract's adaxial surface ..... *T. wynaadensis*
               7. Uniseriate macroform conical hairs absent on bract's adaxial surface
                  8. Uniseriate filiform clavate hairs present on standard petal's margin and ovary ..... *T. canarensis*
                  8. Uniseriate filiform clavate hairs absent on standard petal's margin and ovary ..... *T. candida*
1. Style glabrous
   9. Trichomes present on sepal's adaxial surface
      10. Trichomes absent on bract's adaxial surface ..... *T. villosa*
      10. Trichomes present on bract's adaxial surface
         11. Uniseriate macroform conical hairs present on wing petal
            12. Uniseriate filiform clavate hairs present on ovary ..... *T. barberi*
            12. Uniseriate filiform clavate hairs absent on ovary ..... *T. hamiltonii*
         11. Uniseriate macroform conical hairs absent on wing petal
            13. Uniseriate macroform conical hairs present on keel petal's adaxial surface and margins ..... *T. purpurea*
            13. Uniseriate macroform conical hairs present on keel petal's adaxial surface only ..... *T. hookeriana*

9. Trichomes absent on sepal's adaxial surface
   14. Uniseriate filiform clavate hairs present on ovary
      15. Uniseriate macroform conical hairs 3-celled ..... *T. pumila*
      15. Uniseriate macroform conical hairs mostly 2-celled ..... *T. strigosa*
   14. Uniseriate filiform clavate hairs absent on ovary ..... *T. spinosa*

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BOOK REVIEWS

FACCIOLA, S. 1990. **Cornucopia: A Source Book for Edible Plants.** Kampong Publications, 1870 Sunrise Drive, Vista, CA 92084. Paper $37.75. 677 pp.

Cornucopia is a valuable source book for edible plants. Three thousand species and 7,000 cultivars are listed. Everything from fruits and vegetables to micro-organisms and ferments are included. The first section of the book list 3,000 species alphabetically by family then genus, species, cultivars with a description of how the plant is used, distribution, literature citation, and sources. The section is divided into higher plants, fungi, algae, and bacteria. The second section is a listing of 7,000 cultivars divided into 110 major food crops with days to maturity, important features, origin and sources. The third section is a source list of 1,350 firms and institutions both domestic and overseas, commercial and non-commercial. The indices include: Principal vernacular names, Vernacular and other names occurring elsewhere in the text, Usage of edible plants, Species native to or naturalized in North America, Species not listed in Kunkel and Families and genera. Ethnobotanists, horticulturists, agronomists, alternative farmers, gardeners, researchers and natural food enthusiasts will find this text thorough and the six indices valuable.—*Dotty Woodson.*

LEWINGTON, A. 1990. **Plants for People.** (ISBN 0-19-520849-4). Oxford University Press, Inc., 200 Madison Avenue, New York, NY 10016. Hbk. $39.95. 232 pp.

Anna Lewington presents a fascinating account of the thousands of ways plant products are used from lubricates for engines of supersonic jets to cellulose acetate for films. The text includes seven sections: Starting the Day—soap, shampoo, toothpaste, cosmetics, lotions, perfume and scents; Keeping us Covered—clothes, fabric, kapok for lifejackets, dyeing, printing, shoes, hats; From first foods to fast foods—breakfast food and drinks, coffee and tea; House and Home—wood for timber, furniture, paneling, doors, staircases, veneers and weaving; Your good health—medicines and anesthetics; Getting around—rubber, rails, runways, transport, airplanes, boats, rigging, docks, engines, and fuel; Recreation—paper, paints, film, sports, and instruments. There are hundreds of pictures and botanical drawings depicting source plants, origin and uses. The text is fascinating to read. Horticulturist, botanist, and conservationist will find this book a good reference.—*Dotty Woodson.*

STONES, M. 1991. **Flora of Louisiana.** (ISBN 0-8071-1664-5, Hbk). Louisiana State University Press, Baton Rouge, LA 70893 Hbk. $45.00. 220 pp.

Margaret Stones' botanical illustrations show scientific correctness as well as being a work of art. Stones has painted over 200 watercolor botanical illustrations for the E.A. McIlhenny Natural History Collection at the University of Louisiana in Baton Rouge. This volume represents most of this collection. The listings are alphabetical by plant family. The illustrations are in color and black and white. The appendix gives details about the collected specimens used for the illustrations. This list includes species, collector, date, and locality. Botanists, conservationists, gardeners and horticulturists will find this book valuable.—*Dotty Woodson.*

A NEW WHITE-FLOWERED FORM AND CULTIVAR OF *ILLICIUM FLORIDANUM* (ILLICIACEAE) IN THE SOUTHEASTERN UNITED STATES

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ABSTRACT

Illicium floridanum f. *album* is described as a rare albino form of the Florida anise. Differences between the typical form with reddish purple flowers and the form with white flowers are detailed. The cultivar 'Semmes' is described as a clonal selection derived from *I. floridanum* f. *album* as the wild progenitor. The cultivar was introduced to the nursery trade as a select horticultural plant in 1988.

Illicium floridanum Ellis f. **album** F.G. Mey. & Mazzeo, f. nov.

Distinguitur tepalis eburneis et foliis paulo viridibus, petiolis pallidis ad virides.

Evergreen, glabrous shrub, ca. 2 m in height. Leafy twigs of new growth green. Leaves alternate, simple, aromatic; petioles 1 – 2 cm long, pale green; blades coriaceous, narrowly elliptic, cuneate at the base, acute to acuminate, 9 – 17 cm long, 2.1 – 4.8 cm wide, broadest at or slightly above the middle, entire, minutely glandular-dotted beneath. Flowers usually solitary in leaf axils, with a strong foetid "wet dog" odor, peduncles 3 – 8 cm long, the bud scales 3 – 6, becoming reflexed, broadly ovate and obtuse, glandular-dotted on the outside and ciliate, caducous. Tepals 8 – 21, narrowly oblong, dilated at base, acute or obtuse at the tip, spreading, 2 – 2.8 cm long, 2 – 4 mm wide, white. Stamens numerous, 28 – 36, cream-white. Follicles 10 – 15, separate, 1-seeded, explosively dehiscent.

TYPE: UNITED STATES. MISSISSIPPI. **Lawrence Co.:** understory in woodland, top of embankment along a stream on W side of rte. 27, ca. 0.4 mi N of US 84, NW of Monticello, 14 Apr 1988, *Mazzeo and Dodd 3168* (HOLOTYPE: NA; ISOTYPE: A).

Additional specimens examined: FLORIDA: **Liberty Co.:** steephead, N of Bristol, 18 Apr 1982, *Gholson and Godfrey 9600* (FSU); S side of Little Sweetwater Creek, 16 Apr 1982, *Leonard, Baker and Godfrey 7707* (FSU).

Intermediate with pink tepals. FLORIDA: **Liberty Co.:** near mouth of ravine, SW of Alum Bluff, 16 Apr 1982, *Leonard, Baker and Godfrey 7707 pro parte* (FSU).

Illicium (ANISE TREE) in the southeastern United States is a genus of two species: *I. parviflorum* Michx. ex Vent., confined to central Florida (Lake, Marion, Polk, and Volusia counties), and *I. floridanum*, more widespread in the Florida panhandle

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FIG. 1. *Illicium floridanum* Ellis f. *album* F.G. Mey. & Mazzeo 'Semmes.'

from the Ocklockonee River westward to SW Georgia, the coastal plain of Alabama and Mississippi to SE Louisiana.

Typically, the flowers of *I. floridanum* have pale reddish bud scales, purplish red to deep red tepals, and reddish petioles. About 1975 an isolated plant with white tepals, lighter green leaves, and green petioles was discovered near Monticello, Lawrence Co., Mississippi, growing near plants of *I. floridanum* with typical purplish red to red tepals. Elsewhere, Godfrey (1988) reported both the white-flowered and the intermediate pink-flowered forms growing in ravines east of the Apalachicola River in Liberty Co., Florida. Until now the albino form has not been recognized botanically. Although of minor biological significance, color forms of flowers have value among horticultural plants as cultivars. For this

primary reason, we recognize the white-flowered form of *Illicium floridanum*, both botanically and as a cultivated plant. The cultivar 'Semmes' is described below:

Illicium floridanum Ellis f. **album** F.G. Mey. & Mazzeo cv. '**Semmes**' F.G. Mey. & Mazzeo, cv. nov. (Fig. 1)

CLONOTYPE: UNITED STATES. ALABAMA. **Mobile Co.:** garden of Tom Dodd III, Wulff Rd., Semmes, 14 Apr 1988, *P. M. Mazzeo 3171* (A, AUA, BH, FLAS, GAM, MOR, NA).

'Semmes' is a clonal selection with white flowers, propagated asexually from the type plant of *Illicium floridanum* f. *album* collected in Mississippi (*Mazzeo and Dodd 3168*). (For other details refer to the description of *I. floridanum* f. *album*.) Asexually propagated material of the clonotype plant (*Mazzeo 3171*) has been grown and distributed by Tom Dodd Nurseries of Semmes, Mobile Co., Alabama, since 1988, and subsequently by other nurseries in the United States. It is presently in cultivation at the U.S. National Arboretum in Washington, D.C. as NA 38130.

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LIFE-FORM SPECTRA OF THE MUDFLAT FLORA ON THE SCIOTO RIVER, DELAWARE COUNTY, OHIO

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ABSTRACT

Raunkiaer's life-form designations were used to produce several spectra for the flora of a recently exposed mudflat located on the Scioto River, Delaware County, Ohio. These spectra contain a high percentage of hemicryptophytes, which confirms previous life-form studies of eastern North American floras. However, the high percentage of therophytes (annual plants) in the spectra of a mudflat flora has not previously been reported for this phytoclimatic region, and suggests that localized factors such as disturbance may play a significant role in the determination of life-forms in specific habitats. Altering Raunkiaer's method to include species abundance values had little impact on the resulting spectra calculated for the mudflat flora.

INTRODUCTION

Botanists long have recognized certain specific life-forms in plants (e.g., trees, shrubs, herbs, etc.) but not until the early 20th century were attempts made to study plants as forms produced by their environment (Cain 1950). The Danish botanist Eugenius Warming devised a system that categorized plants according to a "growth-form" (Warming 1909). This complex system placed emphasis on six separate characters, and proved to be too complicated for practical application (Adamson 1939; Cain 1950). Christen Raunkiaer, the successor to Warming as Professor of Botany at the University of Copenhagen, believed something was missing from earlier growth-form schemes, namely that none of them provided a correlation between the vegetation of an area and the associated climate. He devised a life-form classification that relied solely on the position of the perennating buds (growing points) during the least favorable environmental conditions, when the plant was "at rest" (Raunkiaer 1934). Earlier researchers probably placed too much emphasis on the importance of this system. For this reason, Raunkiaer's life-form classification system became unpopular and was neglected for many years (Cain 1950). Since the 1960s, however, life-form studies

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have been conducted on the plants of Kentucky (Gibson 1961), Mackenzie in Northwest Territory (Thieret 1963), Minnesota (Thieret 1967), Michigan (Thieret 1977), Ohio (Luken & Thieret 1988), and Israel (Danin & Orshan 1990).

In using Raunkiaer's life-form classification, most investigations in North America have examined the flora of entire regions and produced a life-form spectrum for a particular region. A life-form spectrum is the percent composition in the flora for each of Raunkiaer's five main life-form classes, which can be simplified as follows (Raunkiaer 1934):

1) **PH** (Phanerophytes) = Perennating buds on shoots in the air at least 25 cm above the soil surface.

2) **CH** (Chamaephytes) = Perennating buds above the soil surface but less than 25 cm high.

3) **HE** (Hemicryptophytes) = Perennating buds at soil surface, usually covered by snow or organic matter during winter.

4) **CR** (Cryptophytes) = Perennating buds protected below soil surface or under water.

5) **TH** (Therophytes) = Annual plants, which survive unfavorable conditions as seeds.

Broad comparisons of life-form or "biological" spectra over different climates and community types may be used to test the hypothesis that, in general, a plant's vegetative body is a result of the broad climatic conditions in which it lives.

Raunkiaer believed that the world can be divided into four major "phytoclimates" (Raunkiaer 1934):

1) **Phanerophytic**–warm, humid tropics
2) **Hemicryptophytic**–deciduous and needle-leaved forests
3) **Therophytic**–tropical and subtropical deserts
4) **Chamaephytic**–high latitudes and altitudes

As a base-line model to be used as a comparison, Raunkiaer devised a "normal spectrum" for the five life-form classes. This "normal spectrum" included 400 species, and was an attempt to devise a phytoclimatic spectrum for the whole planet (Smith 1913). Many of the life-form spectra completed in this country for large regions have tended to support Raunkiaer's hypothesis that the eastern United States belongs in the hemicryptophytic phytoclimate (Table 1).

It has been suggested that more life-form studies should be conducted, especially in specific habitats (Gibson 1961; Thieret 1977). Some of the habitats previously studied in relation to their life-form spectra include Minnesota hardwoods (Buell & Wilbur 1948), Minnesota jack pine forests (Stern & Buell, 1951), New Jersey pine barrens (Stern & Buell 1951), and the Smoky Mountains (Cain 1945). So far as we know, no life-form spectrum has been calculated for a river mudflat flora. An extensively exposed river mudflat along the Scioto River in Delaware County, Ohio, was available for this type of study.

FIG. 1. Rosette of *Rorippa palustris,* an example of a hemicryptophyte on a newly exposed Scioto River mudflat, Delaware County, Ohio. Photo October 1990 by Brian D. Gara.

STUDY SITE

The area studied was a short portion of the Scioto River north of the city of Columbus, Ohio. The mudflat is located directly across from Oller Cemetery on State Route 257, approximately 1.5 km south of the intersection with U.S. route 42. This section of the Scioto River, at the northern end of the O'Shaughnessey reservoir, was artificially drawn down in August 1989 to facilitate construction on the O'Shaughnessey Dam, 9 km downstream. The second author first noticed

TABLE 1: Life-form spectra of native species for selected geographic regions in North America.

Region	Sp #	PH	CH	HE	CR	TH
Normal Spectrum (Raunkiaer 1934)	400	46.0	9.0	26.0	6.0	13.0
Connecticut (Ennis 1928)	1453	15.0	1.9	49.4	21.7	11.7
Gaspé Peninsula and Bic, Quebec (Scoggan 1950)	933	12.1	9.0	49.0	22.1	7.5
Illinois (Hansen 1952)	1734	15.5	1.6	50.2	19.8	12.9
Indiana (McDonald 1937)	1837	15.3	1.7	50.3	19.6	13.0
Iowa (McDonald 1937)	1320	14.8	1.0	48.6	20.9	14.2
Kentucky (Gibson 1961)	1620	17.6	1.4	52.6	16.6	11.8
Michigan (Thieret 1977)	1608	14.2	2.2	51.6	22.1	9.2
Minnesota (Thieret 1967)	1527	13.0	3.0	49.0	22.0	13.0
Ohio (Luken and Thieret 1988)	1730	15.3	1.6	50.0	20.6	12.5

PH (Phanerophytes) = Perennating buds on shoots in the air at least 25 cm above the soil surface.
CH (Chamaephytes) = Perennating buds above the soil surface but less than 25 cm high.
HE (Hemicryptophytes) = Perennating buds at soil surface, usually covered by snow or organic matter during winter.
CR (Cryptophytes) = Perennating buds protected below soil surface or under water.
TH (Therophytes) = Annual plants, which survive unfavorable conditions as seed.
(After Raunkiaer 1934)

the exposed mudflat in September 1990. This site is several hundred meters in width and approximately 1 km long (Fig. 2). According to the Public Information Director for the City of Columbus' Water Division these river sediments had not been exposed by such a drawdown since 1952 (Jackie England, pers. comm.). The dam was re-opened in spring 1991, returning the water to previous levels (i.e., the mudflat is no longer exposed).

METHODS

The identification of each species at the study site was completed during September and October 1990. Nomenclature is according to Kartesz and Kartesz (1980); identification of plants was carried out using Fassett (1957) and Weishaupt (1971). These plants were also compared with specimens in The Ohio State University Herbarium. Several unidentified species had not yet flowered or fruited, and these were transplanted into pots in the OSU Plant Biology Department greenhouse to allow them to complete their life cycle. The com-

pleted list of identified species was arranged in tabular form (Appendix I).The Raunkiaer life-form designation was determined for each species by examining the plants in the field. Each species designation was confirmed with its description in Fernald (1950), and in other life-form studies for regions with a flora similar to Ohio: Indiana (McDonald 1937), Kentucky (Gibson 1961), Connecticut (Ennis 1928), and the Cincinnati region (Withrow 1932). Fernald (1950) was also consulted to determine each species' native or alien status. These mudflat species were also noted as occurring in "wetland" or "upland" situations, a habitat characterization according to Reed (1988). A general estimate of abundance was made for each species from observations made from September to December 1990 (Appendix I). Earlier observations (April-August) may have yielded different values as to species adundancesince some species are undoubtedly more prevalent earlier in the year. We have used abundance values for species to refine the life-form spectrum of this mudflat in two ways:

1) A life-form spectrum was determined for those species that were "common" or "abundant" in the Scioto mudflat community. The rationale for this method was that the less common species ("occasional" and "rare") were relatively unimportant in this ecosystem and therefore could be eliminated without losing much information.

2) Each species was "weighted" based on these abundance values. An abundant species was counted four times, common species three times, occasional species two times, and rare species one time. This method acknowledges the discrepancy in importance for the different species based on their abundance and attempts to account for these differences by weighting each species according to these broad abundance categories.

RESULTS AND DISCUSSION

A river mudflat is usually represented by a narrow band a few meters in width, or as a shallow island that appears or disappears depending on cyclic water-level fluctuations. Our study site was much larger than a typical river mudflat in Ohio. The narrow zone where several species must compete for limited space suddenly was expanded over 100 m across the river bottom. Most of the species colonizing this mudflat emerged from a rich seed bank within the river sediments.

On this mudflat 127 species were recorded. Of these, 90 (70.9%) are native, and 37 (29.1%) are alien. Examination of the habitat classification of these species provides some useful information concerning the biology of this study site (Table 2). A majority of all the species (56.7%) are considered to be either obligate wetland or facultative wetland. Comparison of the native versus alien species shows that most of the native ones (76.7%) are considered "wetland" species ("facultative" or "obligate" wetland), whereas a majority of the alien species (78.3%) are non-wetland or "upland" species ("facultative" or "obligate" upland). This information suggests that two different processes have produced the flora on

FIG. 2. View of Scioto River showing extensive mudflat flora in the foreground and a narrow flowing water zone in the background. Photo October 1990 by Ronald L. Stuckey.

this mudflat. The substrate at this site consists of riverbed sediments, and the species present within the seed bank are the native wetland species that usually grow on the narrow wetland located between the river itself and upland habitats. Once the sediments are exposed as mudflats, many of these seeds germinate, resulting in a flora primarily of native wetland plants. As this mudflat became drier, the site came to resemble a garden or cultivated agricultural field. Because of these changes in the substrate, "weedy," usually wind-dispersed species, more typical of drier habitats, germinated and became established.

Results similar to these on the Scioto River mudflat have been recorded by Bartolotta (1978) for the flora of newly constructed dikes in the marshes of western Lake Erie. Observations during the first year growing season indicated that these new dikes were covered with native wetland species, such as *Polygonum lapathifolium*. These plants emerged from the seed bank located within the sediments used to build the dikes. By the fourth year, the vegetation at the moist base of the dikes still consisted mainly of native species, or 81.5% (53 of 65). Most of these native species, 77.4% (41 of 53), were of wetland habitats. Conversely, at the drier tops of the dikes, only 44.2% (34 of 77) of the species were native. A majority of the alien species colonizing the dike tops, 83.7% (36 of 43) were of upland habitats. The upland alien species presumably entered this habitat via wind dispersal of their seeds or fruits. These data support our findings in the Scioto

TABLE 2: Habitat classification for species present in fall 1990 on a mudflat of the Scioto River, Delaware County, Ohio.

	Sp #	OBL%	FACW%	FAC%	FACU%	UPL%
Native Species	90	40.0	36.7	10.0	8.9	4.4
		76.7				
Alien Species	37	2.7	5.4	13.5	45.9	32.4
					78.3	
Total Species	127	29.1	27.6	11.0	19.7	11. 9
		56.7				

\+ indicates that the species is toward the upper end of this range.
\- indicates that the species is toward the lower end of this range.

OBL (Obligate Wetland) – Species occurring in wetlands greater than 99% of the time.
FACW (Facultative Wetland) = Species occurring in wetlands between 67% and 99% of the time.
FAC (Facultative) = Species occurring in wetlands 34% to 66% of the time.
FACU (Facultative Upland) = Species occurring in upland habitats between 67% and 99% of the time.
UPL (Obligate Upland) = species occurring in uplands greater than 99% of the time.
(Habitat Classification after Reed 1988)

River mudflat flora, and the contention that as the habitat becomes drier, native wetland species become less common within the flora, while upland alien species migrate in and become more prevalent.

Life-form spectra were calculated for all species, native and alien, on this mudflat. These spectra are compared with each other and with other spectra compiled for specific habitats in the United States (Table 3). The high hemicryptophyte component occurring on this mudflat correlates well with previous studies from other localities in eastern United States. The most striking aspect of this mudflat spectrum is the high percent of therophytes. Values this high have not previously been recorded in any life-form spectrum for eastern and midwestern United States (Tables 1 and 3). Perhaps an explanation for this high percentage is that most, if not all, previous studies have been conducted on forest communities, or over large geographic regions composed mainly of upland communities. The effect of small, "disturbed" sites such as river mudflats or similar wetland habitats involving extensive floristic studies would probably be diluted by the enormous proportion of species in more stable habitats. One way to determine the ecological significance of these disturbed areas is to examine their life-form spectra.

Analysis of the alien floristic component of a large geographical area with respect to its life-form spectrum would be another way to examine the effect of disturbance on plant life-forms. For the most part these "alien" species have evolved in areas of human disturbance in the Old World and have colonized North America only where similar sites of disturbance have been artificially created here. Warming had criticized Raunkiaer's work, claiming that the effect

TABLE 3: Life-form spectra of native and alien species for selected locations in North America.

Region	Sp #	PH	CH	HE	CR	TH
Normal Spectrum (Raunkiaer 1934)	400	46.0	9.0	26.0	6.0	13.0
Scioto River Mudflat –all species	127	6.3	1.6	41.7	10.2	40.2
Scioto River Mudflat –native	90	7.8	1.1	41.1	13.3	36.7
Scioto River Mudflat –alien	37	2.7	2.7	43.2	2.7	48.7
Minnesota Hardwoods (Buell and Wilbur 1948)	145	35.9	2.8	44.1	17.2	0.0
Smoky Mountains National Park (Cain 1945)	1142	19.5	1.7	52.1	15.1	11.5
New Jersey Pine Barrens (Stern and Buell 1951)	19	84.2	0.0	10.5	5.2	0.0
Bacon's Swamp, Indiana (Phillips 1929)	164	43.3	1.8	22.6	29.9	2.4
Plains Flora, S. Mackenzie, NWT Canada (Thieret 1963)	558	11.3	7.3	53.8	17.7	9.8
Hydrophytic Community, Cincinnati, Ohio (Withrow 1932)	35	8.6	2.9	31.4	40.0	17.1

PH (Phanerophytes) = Perennating buds on shoots in the air at least 25 cm above the soil surface.
CH (Chamaephytes) = Perennating buds above the soil surface but less than 25 cm high.
HE (Hemicryptophytes) = Perennating buds at soil surface, usually covered by snow or organic matter during winter.
CR (Cryptophytes) = Perennating buds protected below soil surface or under water.
TH (Therophytes) = Annual plants, which survive unfavorable conditions as seed.
(After Raunkiaer 1934)

of non-indigenous species was not considered in his classification scheme (Warming 1908, translated in Du Rietz 1931). Raunkiaer responded by saying that no reason was evident to believe that the life-form spectrum would be altered by the presence of alien species, as most of these species would have emigrated from an area with a similar phytoclimate (Raunkiaer 1934). Data from this study, and the little information that could be gleaned from the literature show a noteworthy trend (Table 4). In all of these spectra the percent of therophyte species is much higher than would be expected from the hemicryptophytic phytoclimate. Apparently environmental and/or human disturbance can and does have a significant impact on the life-form spectrum, or more importantly, on the "survival strategy" of these species.

One potential problem to the method used to produce the life-form spectra in the development of this paper, and other papers, involves the concept of species

TABLE 4: Life-form spectra for alien species in selected geographic regions of North America.

Region	Sp	PH	CH	HE	CR	TH
Normal Spectrum (Raunkiaer 1934)	400	46.0	9.0	26.0	6.0	13.0
Scioto River Mudflat	37	2.7	2.7	43.2	2.7	48.7
Indiana (McDonald 1937)	272	7.7	3.3	40.1	7.4	41.5
Kentucky (Gibson 1961)	226	7.1	1.3	41.6	4.9	45.1
Connecticut (Ennis 1928)	169	12.4	3.6	46.7	8.3	29.0
Bull Run Mountain, Virginia (Allard 1944)	133	12.0	0.0	52.6	6.8	29.3

PH (Phanerophytes) = Perennating buds on shoots in the air at least 25 cm above the soil surface.
CH (Chamaephytes) = Perennating buds above the soil surface but less than 25 cm high.
HE (Hemicryptophytes) = Perennating buds at soil surface, usually covered by snow or organic matter during winter.
CR (Cryptophytes) = Perennating buds protected below soil surface or under water.
TH (Therophytes) = Annual plants, which survive unfavorable conditions as seed.
(After Raunkiaer 1934)

importance. In producing the spectrum, all species are given equal "weight" as to their importance in the community, even though some are represented by one individual on the entire mudflat, whereas others have thousands of individuals in the same location. Therefore, it may be argued that these data have no real ecological significance. The abundance values of the species determined for this mudflat are in some respects arbitrary, but they do provide at least an approximate indication of the ecological importance of each species. The results of the two spectra produced using these abundance data have been compared to the other life-form spectra determined for this mudflat habitat (Table 5). It seems that the alternate methods have not substantially changed the life-form spectrum from the original, more traditional method. The therophyte and hemicryptophyte components remain the most important, and the approximate percentages of each remain virtually constant, regardless of whether or not abundance values are used when determining the life-form spectrum.

CONCLUSION

Examination of the life-form spectrum on a recently exposed river mudflat has produced some noteworthy results. The spectrum gives some indication as to the level of protection individual species must "provide" for their perennating buds to insure survival through the least favorable environmental conditions. It is evident from previous life-form studies that the general climatic conditions in a

TABLE 5: Life-form spectra for the Scioto River mudflat using various methods.

Region	Sp #	PH	CH	HE	CR	TH
Normal Spectrum (Raunkiaer 1934)	400	46.0	9.0	26.0	6.0	13.0
Scioto River Mudflat –all species	127	6.3	1.6	41.7	10.2	40.2
Scioto River Mudflat –native species	90	7.8	1.1	41.1	13.3	36.7
Scioto River Mudflat –alien species	37	2.7	2.7	43.2	2.7	48.7
Scioto River Mudflat –Common or Abundant species	42	2.4	0.0	45.2	7.1	45.2
Scioto River Mudflat –all species, "weighted" (based on abundance values)	127	5.2	1.2	42.3	8.4	42.3

PH (Phanerophytes) = Perennating buds on shoots in the air at least 25 cm above the soil surface.
CH (Chamaephytes) = Perennating buds above the soil surface but less than 25 cm high.
HE (Hemicryptophytes) = Perennating buds at soil surface, usually covered by snow or organic matter during winter.
CR (Cryptophytes) = Perennating buds protected below soil surface or under water.
TH (Therophytes) = Annual plants, which survive unfavorable conditions as seed.
(After Raunkiaer 1934)

geographic region have a major role in the floristic composition of that region. The Scioto River mudflat flora in central Ohio also appears to have been produced with similar environmental constraints. Hemicryptophytes comprise the major component of the life-form spectrum for this site, which was to be expected as this mudflat is located in the phytoclimate where hemicryptophytes normally predominate. The exceedingly high percentage of therophytes in this life-form spectrum was unexpected, however, and suggests that other, more localized environmental factors (e.g., annual flooding) may have a significant role in the life-forms present in certain habitats.

The presence of non-indigenous species also appears to have an impact on the life-form spectra as determined for floras of state-wide geographic regions. These alien species are more evident in small areas of severe disturbance, and the alien floristic components have a higher percentage of therophytes in their life-form spectra than has otherwise been reported for broader regions.

Altering the traditional method for calculating life-form spectra to include species abundance data did not significantly change the percentages of these mudflat species in each of the five life-form categories.

APPENDIX I. Plant species on newly exposed mudflat of the Scioto River, Delaware County, Ohio–September/December 1990.

Scientific Name	Life-Form	Native or Alien	Abundance	Habitat Classification
Abutilon theophrasti	TH	A	R	UPL
Acer negundo	PH	N	O	FAC+
Acer saccharinum	PH	N	R	FACW
Acorus americanus (*A. calamus*)	CR	N	R	OBL
Alisma plantago-aquatica	CR	N	C	OBL
Amaranthus albus	TH	N	R	FACU
Amaranthus tuberculatus	TH	N	A	FACW
Ambrosia trifida	TH	N	R	FAC
Ammannia robusta[1]	TH	N	O	OBL
Artemisia annua	TH	A	O	FACU
Asclepias incarnata	HE	N	O	OBL
Aster simplex	HE	N	A	FACW
Atriplex patula	TH	N	O	FACW
Bidens cernuus[2]	TH	N	C	OBL
Bidens connatus	TH	N	O	FACW+
Bidens frondosus	TH	N	C	FACW
Bidens tripartitus (*B. comosus*)	TH	N	C	FACW
Capsella bursa-pastoris	TH	A	R	FACU
Chenopodium album	TH	A	O	FACU+
Chenopodium ambrosioides	HE	A	R	FACU
Chenopodium bushianum	TH	N	R	UPL
Convolvulus arvensis	CR	A	R	UPL
Conyza canadensis	TH	N	R	UPL
Cuscuta gronovii	TH	N	O	UPL
Cyperus aristatus (*C. inflexus*)	TH	N	C	FACW+
Cyperus erythrorhizos	TH	N	R	FACW+
Cyperus esculentus	CR	N	R	FACW
Cyperus odoratus (*C. ferruginescens*)	TH	N	O	FACW
Cyperus rivularis	TH	N	R	FACW+
Cyperus strigosus	CR	N	C	FACW
Daucus carota	HE	A	R	UPL
Dichanthelium clandestinum (*Panicum clandestinum*)	HE	N	R	FAC+
Digitaria ciliaris (*D. sanguinalis*)	TH	A	R	FACU-
Dipsacus fullonum (*D. sylvestris*)	HE	A	O	UPL
Echinochloa muricata (*E. pungens*)	TH	N	O	FACW+
Echinocystis lobata	TH	N	R	FAC
Eclipta prostrata (*E. alba*)	TH	N	C	FAC
Eleocharis intermedia	TH	N	R	FACW+
Eleocharis obtusa	TH	N	C	OBL
Eleusine indica	TH	A	R	FACU-
Epilobium coloratum	HE	N	R	OBL

(Appendex I continued)

Scientific Name	Life-Form	Native or Alien	Abundance	Habitat Classification
Eragrostis hypnoides	TH	N	A	OBL
Erigeron philadelphicus	HE	N	C	FACU
Eupatorium perfoliatum	HE	N	O	FACW+
Galinsoga quadriradiata (*G. ciliata*)	TH	A	O	UPL
Glechoma hederacea	HE	A	R	FACU
Gleditsia triacanthos	PH	N	O	FAC-
Gratiola neglecta	TH	N	R	OBL
Helenium autumnale	HE	N	C	FACW+
Hibiscus laevis (*H. militaris*)	HE	N	O	FACW+
Hibiscus trionum	TH	A	O	UPL
Impatiens capensis	TH	N	O	FACW
Juncus effusus	HE	N	R	FACW+
Juncus tenuis	HE	N	C	FAC-
Justicia americana	CR	N	R	OBL
Leersia oryzoides	HE	N	O	OBL
Leersia virginica	HE	N	R	FACW
Leonurus marrubiastrum	HE	A	R	UPL
Lindernia dubia	TH	N	C	OBL
Lobelia siphilitica	HE	N	R	FACW+
Ludwigia palustris	HE	N	C	OBL
Lycopus americanus	HE	N	C	OBL
Lycopus x sherardii	HE	N	R	OBL
Lycopus uniflorus	HE	N	O	OBL
Lycopus virginicus	HE	N	R	OBL
Lysimachia nummularia	CH	A	O	OBL
Malva neglecta	HE	A	C	UPL
Melilotus sp.	HE	A	R	FACU
Mentha arvensis	HE	N	C	FACW
Mimulus alatus	HE	N	O	OBL
Mimulus ringens	HE	N	A	OBL
M. ringens x M. alatus	HE	N	R	OBL
Mollugo verticillata	TH	A	R	FAC
Morus alba	PH	A	R	FACU
Oxalis stricta	HE	N	R	UPL
Panicum dichotomiflorum	TH	N	R	FACW-
Penthorum sedoides	HE	N	A	OBL
Phalaris arundinacea	CR	N	C	FACW+
Phyla lanceolata (*Lippia lanceolata*)	HE	N	C	OBL
Physostegia virginiana	HE	N	R	FAC+
Pilea pumila	TH	N	O	FACW
Plantago lanceolata	HE	A	R	UPL
Plantago major	HE	A	C	FACU
Plantago rugelii	HE	N	R	FACU
Polygonum aviculare	TH	A	R	FACU
Polygonum hydropiper	TH	N	C	OBL
Polygonum lapathifolium	TH	N	A	FACW+
Polygonum pensylvanicum	TH	N	A	FACW
Polygonum persicaria	TH	A	C	FACW

(Appendex I continued)

Scientific Name	Life-Form	Native or Alien	Abundance	Habitat Classification
Polygonum punctatum	TH	N	C	OBL
Populus deltoides	PH	N	C	FAC
Portulaca oleracea	TH	A	C	FAC
Potentilla norvegica	HE	A	C	FACU
Ranunculus sceleratus	TH	N	C	OBL
Rorippa palustris	HE	N	C	OBL
Rorippa sylvestris	HE	A	R	FACW
Rudbeckia laciniata	HE	N	O	FACW
Rudbeckia triloba	HE	N	R	FACU
Rumex crispus	HE	A	C	FACU
Rumex obtusifolius	HE	A	R	FACU-
Rumex verticillatus	HE	N	O	OBL
Sagittaria latifolia	CR	N	O	OBL
Salix discolor	PH	N	R	FACW
Salix exigua (*S. interior*)	PH	N	O	OBL
Salix nigra	PH	N	R	FACW+
Samolus valerandi (*S. parviflorus*)	HE	N	C	OBL
Saururus cernuus	CR	N	R	OBL
Scirpus pungens (*S. americanus*)	CR	N	R	OBL
Scirpus tabernaemontani (*S. validus*)	CR	N	R	OBL
Scrophularia marilandica	HE	N	R	FACU-
Scutellaria lateriflora	HE	N	O	FACW+
Setaria glauca	TH	A	R	FAC
Setaria viridis	TH	A	R	UPL
Sida spinosa	TH	A	R	UPL
Solanum nigrum	TH	A	C	FACU-
Solidago canadensis	HE	N	C	FACU
Sonchus asper	TH	A	O	FAC
Stachys palustris	CR	N	R	OBL
Trifolium pratense	HE	A	R	FACU-
Typha latifolia	CR	N	O	OBL
Urtica dioica	HE	A	C	FACU
Verbascum thapsus	HE	A	O	UPL
Verbena hastata	HE	N	C	FACW+
Verbena urticifolia	HE	N	O	FACU
Veronica catenata	CH	N	R	OBL
Veronica peregrina	TH	N	C	FACU-
Xanthium strumarium	TH	A	C	FAC

[1]Following the treatment of S.A. Graham (Taxon 28:169 – 178. 1979).
[2]We have used the -us endings for the epithets in *Bidens*, according to E.G. Voss (Michigan Botanist 16:138. 1977).
A (Abundant) = Species extremely numerous; considered a dominant species in some part of the community.
C (Common) = Many individuals scattered throughout mudflat community.
O (Occasional) = A few individuals present on mudflat (more than 5).
R (Rare) = 1 to 5 individuals present on mudflat.

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ADDITIONAL STUDIES OF *ASTER GEORGIANUS*, *A. PATENS*, AND *A. PHLOGIFOLIUS* (ASTERACEAE)

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ABSTRACT

Additional information is presented on the distributions, habitats, and associates of *Aster* section *Patentes*. Seven new counties are reported for *A. georgianus*, 28 for *A. patens*, and 16 for *A. phlogifolius*. *Aster georgianus* is described as a rare species of the southern United States, and deserving of additional studies to determine its federal status. *Aster patens* is a widespread species of the eastern United States and divisible into three geographic varieties. *Aster phlogifolius*, an Appalachian taxon, should be treated at the specific level because of consistent morphological, ecological, and physiological differences from *A. patens*.

RESUMEN

Se presenta información adicional sobre la distribución, habitats, y especies asociades de *Aster* sección *Patentes*. Siete nuevos condados son reportados para *A. georgianus*, 28 para *A. patens*, y 16 para *A. phlogofolius*. Se describe *Aster georgianus* como una especie rara de el sur de los Estados Unidos, la cual merece estudios adicionales para determinar su estado legal federal. *Aster patens* es una especie de amplia distribución de el oriente de los Estados Unidos y que se divide en tres variedades geográficas. *Aster phlogifolius*, un taxón de los montes Apalaches, debe ser tratado al nivel de especie debido a las diferencias consistentes de morfología, ecología y fisiología sobre *A. patens*.

INTRODUCTION

Three species were recognized in *Aster* section *Patentes*: *A. georgianus* Alex., *Aster patens* Ait. (with three varieties), and *A. phlogifolius* Muhl. ex Willd. (Jones 1983). Most previous workers had considered all these taxa as conspecific with *A. patens*. Because *A. georgianus* is now known to be a decaploid species (2n=50) with a distinct morphology, it has been generally accepted as a distinct species associated with the Piedmont of North and South Carolina, Georgia, and Alabama. The Georgia aster has been receiving increased attention since being listed as a Category 2 taxon on the Federal Register (USFWS 1990), and I have received a number of requests in the last two years for more information on the taxon. Species status for *A. phlogifolius*, however, has met with less acceptance, especially from some of the major workers in the genus (A. Jones and Hiepko 1981 and A. Jones pers. comm.; Semple 1984; Gleason and Cronquist 1991). *A. phlogifolius* and *A. patens* are identical in chromosome number (2n=20) in the areas of range overlap, and they can cross. In my opinion, they do exhibit distinct morphological,

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physiological, and ecological characters. The objective of this paper is to update the available information on all the taxa in *Aster* section *Patentes* and to provide additional data to support the existence of genetic and taxonomic differences between *A. phlogifolius* and *A. patens*.

MATERIALS AND METHODS

Additional information on distributions and associates of these taxa was accumulated through field studies and herbarium searches. Vouchers from field work have been deposited at EKY. The following herbaria were consulted to provide additional distributional information: BEREA, EKY, FLAS, WIS, UNA, US and VDB (Holmgren et al 1990).

Achenes representative of each taxon were photographed at 100X using a Scanning Electron Microscope at Auburn University. For seedling comparisons, achenes were planted in sand and allowed to germinate, removed at the emerging radicle stage, the cotyledon stage, and the 3rd cauline leaf stage, and drawings were made of each stage.

Germination studies were conducted on achenes collected from contiguous populations of *Aster patens* and *A. phlogifolius* in Rowan County, Kentucky, and from another population of *A. patens* in Menifee County, Kentucky. The basic procedures of Baskin and Baskin (1979) were followed, using at least 50 achenes per petri dish, two or three replications per treatment, and monitored for 16 weeks.

RESULTS AND DISCUSSION

Aster georgianus: Distribution and Associates

A total of 21 counties have been mapped for *Aster georgianus*, but it was noted that extant populations were known from only nine sites (Jones 1983). Further field and herbarium studies since 1983 have resulted in the documentation of the following new counties: **Alabama**. Shelby County, *Kral 68027* (VDB). **North Carolina**. Gaston Co., 7 Oct 1902, *collector unknown*, (US) Rowan Co.: *Jones 4602* (EKY). **South Carolina**. Lauren Co.: *Jones 4631* (EKY); Union Co.: *Jones 4622* (EKY); and York Co.: *Jones 4620* (EKY). Semple (1984) reported the species with its decaploid count of 2n=50 from Oconee Co., South Carolina. Alan Weakley, North Carolina Natural Heritage Botanist, reports finding this plant in Mecklenberg County, North Carolina (pers. comm.). Thus *A. georgianus* has been reported from 29 counties, but only 16 extant populations have been located during the last 15 years.

Isotypes of *Aster georgianus* were not listed in my 1983 paper, but a duplicate of the 1898 Cuthbert collection from Richmond Co., Georgia, has subsequently been located at FLAS.

Most of the known populations of *Aster georgianus* are small, consisting of colonial stands of 10 to 100 stems. It is likely that these stems represent just a few genotypes at each site. The populations occur along dry, fairly open roadsides in communities dominated by *Quercus falcata* Michx., *Q. alba* L., *Q. coccinea* Moenchh., *Q. stellata* Wang., *Liquidambar styraciflua* L., *Nyssa sylvatica* Marsh., *Prunus serotina* Ehrh., *Pinus echinata* Mill., *P. taeda* L., *P. virginiana* Mill., *Cornus florida* L., and *Sassafras albidum* (Nutt.) Nees. Herbaceous species at these sites included *Aster patens* Ait., *A. grandiflorus* L., *A. undulatus* L., *Arnica acaulis* (Walt.) BSP, *Chrysopsis graminifolia* (Michx.) Elliott, *C. mariana* (L.) Elliott, *Helianthus angustifolius* L., *Solidago erecta* Pursh, *S. nemoralis* Ait., *Agalinus purpurea* (L.) Pennell, *Scutellaria alabamensis* Alex., *S. elliptica* Muhl., *Lobelia puberula* Michx., and *Erianthus contortus* Baldw. Alan Weakley (pers. comm.) views *Aster georgianus* as a relict species of post oak-savanna communities that were once fire-maintained in North Carolina. He has found other federally listed plants in association with *A. georgianus*, including *Helianthus schweintzii* Torrey & Gray, and *Lotus purshianus* (Bentham) Clements & Clements var. *helleri* (Britt.) Isely, both Category 2 taxa on the Federal Register (USFWS 1990). Weakley also reports that most of the known sites for *A. georgianus* in North Carolina harbor only a few plants, and some have recently been influenced by habitat disturbance.

Aster patens: Distribution and Associates

Aster patens is a widespread species of the eastern U.S. It can be divided into three fairly well-marked varieties: var. *patens*, the common tetraploid (2n=20) east of the Mississippi River; var. *patentissimus* (Lindl.) Torrey & Gray, the common tetraploid of the Ozarks and adjacent areas; and var. *gracilis* Hooker, the primarily diploid (2n=10) taxon of the southwestern portions of the range. Further chromosome counts of these taxa by Semple (1984) supported my postulate that diploid plants occur only as far east as central Alabama.

Field and herbarium studies have resulted in the following county records for the var. *patens* that were not mapped in Jones (1983):

Arkansas. Miller Co.: *Palmer 14621* (US). **Kentucky.** Barren Co.: *Johnson 1047* (EKY); Elliott Co.: *Jones 4590* (EKY); Estill Co.: 10 Oct 1978, *Martin* (EKY); Harlan Co.: *Thompson 87-1724* (BEREA); Hart Co.: *Braun 3606* (US); Lawrence Co. *Jones 4575* (EKY); Lee Co.: *Thompson 85-1639* (BEREA); Letcher Co.: *Braun 827* (US); Madison Co.: *Braun 597* (US); Menifee Co.: *Jones 4385* (EKY); Rockcastle Co.: *Godbey 585* (EKY); Whitley Co.: *Braun 2621* (US). **Maryland**. Allegheny Co.: 20 Sep 1881, *Smith* (US). **Ohio**. Adams Co.: 6 Oct 1965, *Braun* (US). **Oklahoma**. Logan Co.: Aug 1891, *Carlton* (WISC). **North Carolina**. Craven Co.: *Kearney 2208* (US). **New York**. Dutchess Co.: Sep 1875, *Scribner* (US). **South Carolina**. Anderson Co.: *Davis 8497* (US). **Virginia**. Bath Co.: 9 Sep 1907, *Steele* (US); Rockbridge Co.: 11 Sep 1904, *Steele* (US).

New documentation for county records of var. *gracilis* is as follows:

Alabama. Autauga Co.: *Gunn 1202* (UNA); Lowndes Co.: *Gunn 1371* (UNA); Wilcox Co.: *Gunn 1344* (UNA). **Kansas**. Gray Co.: *Carlton 429* (US). **Mississippi**. Attala Co.: *McDougall*

1147 (US); Madison Co.: *McDougall 1487* (US). **Oklahoma**. Choctaw Co.: 13-15 Oct 1896, *Schuchert* (US). The Gray County, Kansas record for the var. *gracilis* represents the furthest known westward extension of the species. No new counties were found for *Aster patens* var. *patentissimus*.

Aster patens is found in a variety of habitats (Jones 1983). In its southern range it can be found with many of the same associated species as listed above for *Aster georgianus*. The species is primarily one of woodland edges and disturbed areas, often occurring in partial to full sun.

Aster phlogifolius: Distribution and Associates

Aster phlogifolius is a tetraploid species closely associated with Appalachian habitats. It was mapped from southern New York across Pennsylvania to northern Ohio to southern Indiana to northeastern Alabama (Jones 1983). The following counties represent additions to the known distribution:

Kentucky. Bell Co.: *Thompson 85-1672* (BEREA); Estill Co.: *Guetig 382* (EKY); Jackson Co.: *Abner 91-2* (EKY); Laurel Co.: *Thompson 88-2819* (BEREA); Lee Co.: *Thompson 85-1638* (BEREA); Lewis Co.: *Braun 4387* (US); Rowan Co.: *Braun 1671* (US). **Maryland**. Garrett Co.: 4 Oct 1878, *Smith* (US); Kensington Co.: *Standley 5951* (US). **Ohio**. Montgomery Co.: *VanCleve* (US). **Virginia**. Allegheny Co.: *Leonard 16986* (US); Augusta Co.: *Steele 161* (US); Nelson Co.: *Steele 44* (US); Page Co.: *Walker 2682* (US). **West Virginia**. Pendleton Co.: *Killip 36060* (US).

Aster phlogifolius is typically found in more mesic habitats than *A. patens*, often above cool streams on shaded, boulder slopes. Typical associates include *Quercus alba* L., *Q. rubra* L., *Tsuga canadensis* (L.) Carr., *Acer rubrum* L., *A. saccharum* Marsh., *Fagus grandifolia* Ehrh., *Magnolia acuminata* (L.) L., *M. tripetala* L., *Aster shortii* Lindl., *Polymnia canadensis* L., and *Polygonatum biflorum* (Walt.) Ell. Population contact between *Aster phlogifolius* and *A. patens* may occur in the event of habitat disturbance, i.e., power-line cuts or road building and there are usually a few individuals that appear to be hybrids. Nevertheless, there is no evidence of a high degree of introgression, and in every case the taxa can still be easily distinguished by characteristic morphological features (Jones 1983). At one such site in Rowan County, KY (the one sampled for achene germinations, see below), the populations of *Aster phlogifolius* and *A. patens* occurred along a south-facing slope over about a two km stretch of gravel road. The former species was mostly restricted to the more shady, protected areas of the upper slopes, while the latter occurred along the right of way, often in full sun. In some cases individuals of each taxon occurred side by side.

I have spent a considerable amount of time searching for large populations of *A. phlogifolius* in eastern Kentucky, but with very little success. Some sites where it once occurred in Tennessee have now been destroyed, and at others the populations are barely persisting. This species is very intolerant of habitat disturbance, and as the percentage of relatively undisturbed Appalachian forest declines, so will the abundance of this plant.

Achene and Seedling Morphology

While the achenes of *Aster patens* and *A. georgianus* differ only in size, those of *A. phlogifolius* are distinctly different (Jones 1983). Scanning electron photographs of the lower portions of the achenes are included here to present further evidence of these differences (Fig. 1). Achene trichomes of *A. phlogifolius* are much more restricted to the achene ridges, thus appearing to be in rows, and are more appressed and shorter (less than 0.4 mm long) than those of *A. georgianus* and *A. patens*. *A. phlogifolius* achenes also are bulkier and darker, varying to black. These consistent mature achene features are important taxonomic characters for *A. phlogifolius*, and are probably often overlooked by those attempting to separate this taxon from *A. patens*.

A brief mention of seedling leaf differences between *A. patens* and *A. phlogifolius*, and a photograph of young rosette leaves were presented in Jones (1983). A series of line drawings are given to emphasize the fact that these differences are exhibited from the time the first cauline leaf emerges above the cotyledons (Fig. 2). *A. georgianus* seedlings are larger than those of *A. patens*, but are otherwise very similar. The seedlings of these asters possess a short hypocotyl which raises the cotyledons slightly above the ground. The cotyledons are ovate-spathulate to orbicular-spathulate, and the first few seedling leaves in both are lanceolate-attenuate, and pubescent. The young cauline leaves of *A. phlogifolius*, when compared with those of *A. patens*, are thinner, with more pronounced veins, and with longer, curlier trichomes, thus foreshadowing the later characteristic leaf features of the species.

Achene Germination

An earlier study lead to the conclusion that the achenes of *A. patens* and *A. georgianus* germinated very easily but that the those of *A. phlogifolius* required a cold treatment for good germination (Jones 1983). After a reexamination of the data and another series of experiments, these conclusions now must be modified. A two-week germination study in 1979, using two populations of each taxon as achene sources, with standard techniques, at 14 hour photoperiods, found the following:

1) In *A. patens* 56, 87, and 76% achene germination was achieved at 15.6/4.4, 21/10, and 26.6/15.6° C, respectively, without stratification.
2) In *A. phlogifolius* 10, 28, and 61% achene germination was achieved at the above temperatures, without stratification.
3) The achenes of both taxa germinate maximally (over 90%) at 15.6/4.4 and 21/10° C after being subjected to a 12-week stratification period at 4° C.

In 1985, further studies on the achene germination of *A. patens* and *A. phlogifolius* were carried out at the laboratory of Jerry and Carol Baskin at the

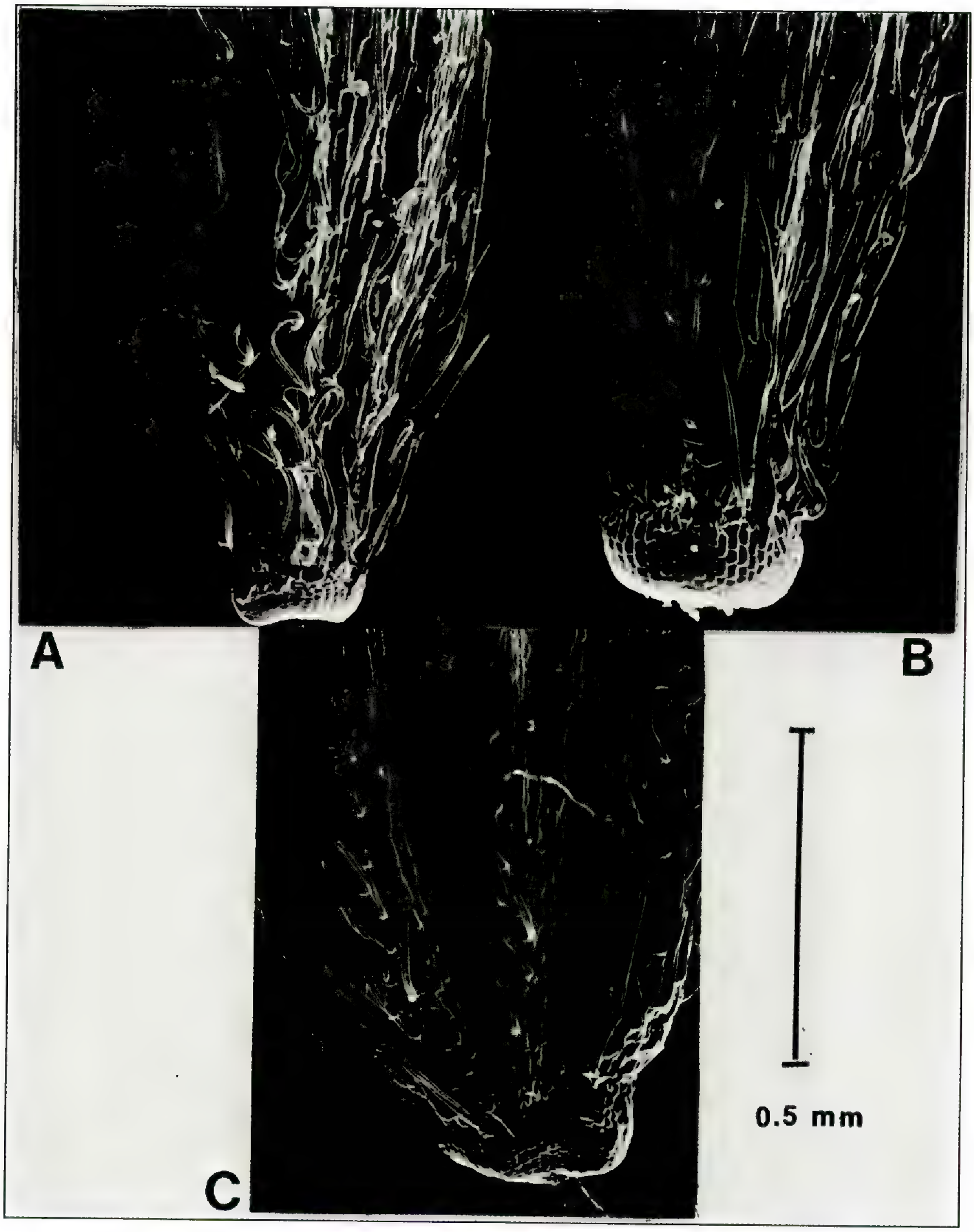

FIG. 1. Scanning electron photographs (100X) of achene bases of *Aster patens* (A), *Aster georgianus* (B), and *Aster phlogifolius* (C).

University of Kentucky. The results are presented in Table 1. These data show a comparison between adjoining populations of *A. phlogifolius* and *A. patens* in Rowan County, Kentucky, and another population of *A. patens* from Menifee County, Kentucky. The following is a summary of the results:

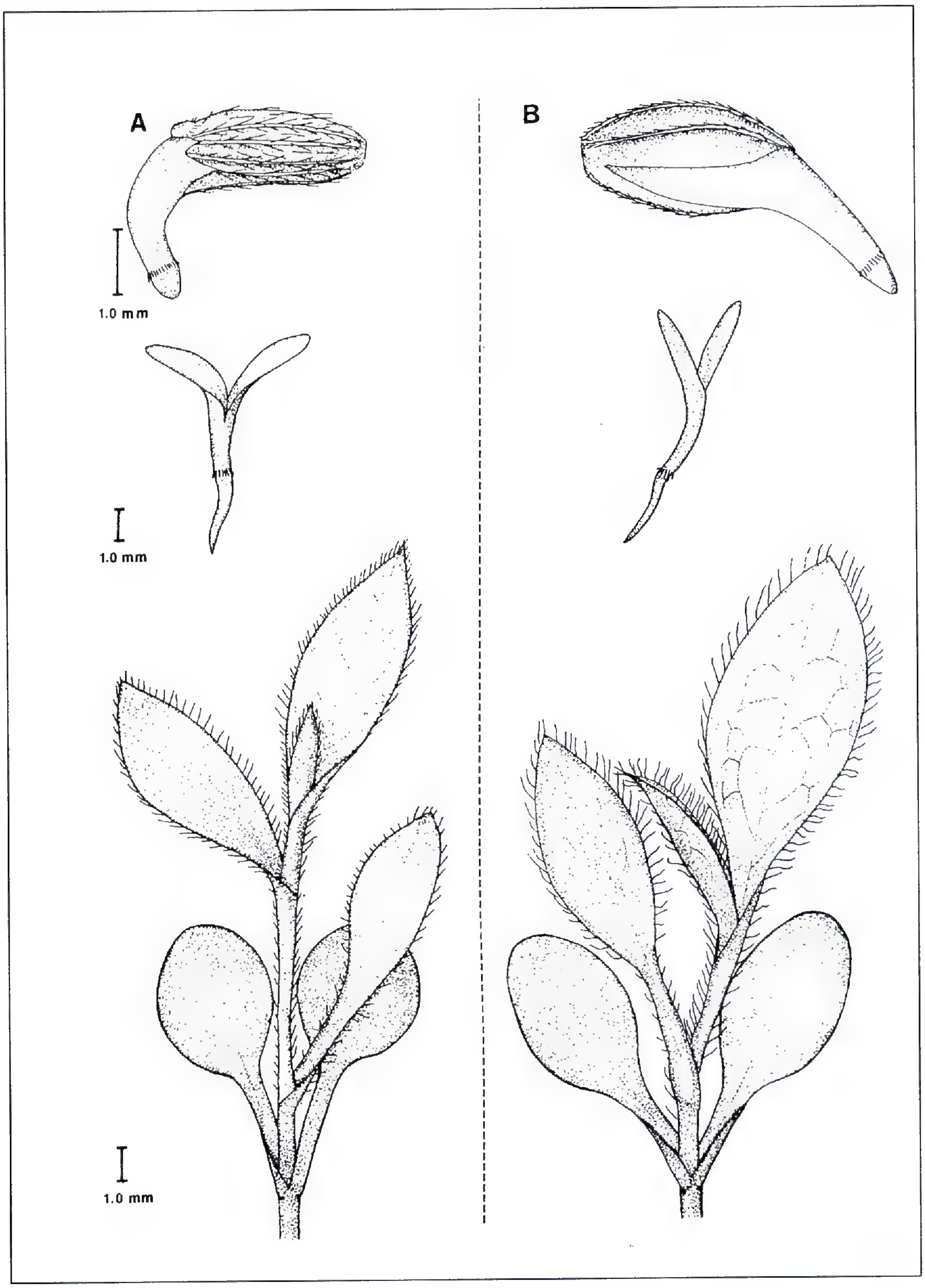

FIG. 2. Young seedling development in *Aster patens* (A) and *Aster phlogifolius* (B).

1) Both populations of *A. patens* had almost identical patterns of germination, with near-maximal germination after two weeks at all regimes from 15/6 to 30/15° C, but showing some decrease at 35/20° C.

TABLE 1. Achene germination percentages (mean + SD) of *Aster phlogifolius* and *A. patens*. Techniques of Baskin and Baskin (1979) were used except that the middle column of data is based on a duplicate set of dishes instead of a triplicate set.

Temp (c) and Weeks (W)	*A. phlogifolius* Rowan County	*A. patens* Rowan County	*A. patens* Menifee County
15/6			
2W	2 ± 3	75 ± 2	93 ± 5
8W	21 ± 10	95 ± 7	96 ± 2
16W	84 ± 9	97 ± 4	96 ± 2
20/10			
2W	5 ± 4	100	100
8W	25 ± 10	—	—
16W	25 ± 13	—	—
25/15			
2W	12 ± 4	96 ± 3	90 ± 4
8W	15 ± 5	100	98 ± 1
16W	17 ± 6	—	98 ± 1
30/15			
2W	65 ± 26	96 ± 6	98 ± 1
8W	78 ± 20	100	100
16W	78 ± 20	—	100
35/20			
2W	43 ± 30	55 + 1	83 ± 15
8W	46 ± 30	62 ± 6	83 ± 15
16W	49 ± 30	63 ± 4	83 ±15
Pretreatment 5 C for 12W			
15/6			
2W	35 ± 12	100	100
4W	100	—	—
20/10			
2W	100	—	—
4W	100	—	—
25/15			
2W	98 ± 2	—	—
4W	100	—	—
30/15			
2W	99 ± 1	—	—
4W	100	—	—
35/20			
2W	59 ± 35	—	—
4W	60 ± 35	—	—

2) *A. phlogifolius* showed a very different pattern, with rates of under 25% at 15/6 (except at 16 weeks), 20/10, and 25/15° C, rates of 65-78% at 30/15° C, and 42-49% at 35/20° C. In the 15/6° C treatment, the germination totals nearly doubled between 10 and 16 weeks, up to 84%. It appears, therefore, that this 15/6° C treatment actually stratified the achenes, and stimulated germination after a period of 10 – 12 weeks. As in *A. patens*, germination was stimulated by moderate warmth (30/15° C) but inhibited by greater heat (35/20° C).
3) Both taxa showed generally maximal germination either during or after a cold treatment of 12 weeks. All of the achenes of *A. patens* germinated during the cold treatment. About 30% of *A. phlogifolius* achenes germinated during the cold treatment, the remainder soon thereafter at all regimes except the hottest.

Thus the results obtained in experiments conducted in 1979 and 1985 are very similar, but a more accurate conclusion based on both sets of data can now be stated: the freshly matured achenes of *A. patens* are nondormant, while those of *A. phlogifolius* are conditionally dormant and thus germinate to 50% or more only above 30/15° C. Therefore, *A. phlogifolius* achenes require a cold treatment for good germination *at low temperatures*, but not at warmer temperatures. Stratification lowers the minimum temperature for germination of *A. phlogifolius* achenes, and this effect was noted by Baskin and Baskin (1988) for nearly all tested Compositae achenes with low-temperature dormancy at maturity.

The germination patterns of these two species may be correlated with their distributions. *A. phlogifolius* is primarily an Appalachian taxon, and these populations have become adapted to an alternating cold/warm season climate. The low temperature dormancy would prevent large numbers of achenes from germinating in the late fall, with subsequent seedling loss over the winter. The achenes would experience natural stratification over the winter, and would then be able to germinate during the cool temperatures of the early spring, allowing enough time for seedling establishment prior to summer drought. Baskin and Baskin (1988) found a similar strategy existed among many herbaceous plants of mesic forests.

Aster patens is primarily a southern species that occurs in a variety of upland and lowland habitats. It is much hardier, more weedy species than *A. phlogifolius*. With nondormant achenes it is likely that seedling establishment does take place in the fall, especially in the more southerly parts of its range. Whether fall-germinated seedlings can survive the colder winters in the northerly habitats of the species is not known. These achene germination patterns may be indicative of a more specialized adaptive system in *A. phlogifolius* and a more generalized adaptive system in *A. patens*. Achene germination differences do exist, and further point toward the genetic and physiological divergence of these two taxa.

CONCLUSIONS

Aster georgianus has been collected from only 16 counties in the southeastern U.S. during the last 15 years. It is likely to have originally inhabited oak-savanna type communities, but with the disappearance of these habitats, it now persists primarily along open or partially open savanna remnants, woodland borders and roadsides. The species is unique among base-5 asters, being the only known decaploid, and its phylogenetic relationships with *A. patens* and other similar asters are unknown (Jones 1983; Semple 1984). More detailed studies are needed on habitat requirements, demography, genetics, and distributions. Currently a Category 2 plant on the Federal Register, *A. georgianus* deserves a high priority as the subject of a status survey report by the United States Fish and Wildlife Service.

Aster phlogifolius is obviously very closely related to *A. patens*, and the question arises as to subspecific or specific treatment. Leaf, phyllary, floret, and achene differences provide consistent taxonomic markers. Leaf differences are evident from the very early stages of seedling growth. Further evidence of genetic divergence is suggested by the differences in habitat, reactions to disturbance, and in achene germination. They have not diverged sufficiently to prevent crossing, but these tetraploid Appalachian populations have developed their own evolutionary lineage and have accumulated sufficient genetic differences through ecological isolation to make them morphologically different. Therefore, I still maintain their treatment as different species. Species status would draw more attention to this taxon, which could be used as an indicator species of mesic Appalachian communities. Recent field studies suggest that this plant is on the decline in many areas, and its loss should be of concern to those interested in preserving the rich assemblage of species that occur in our Appalachian forests.

Aster patens and related taxa provide a good model for studying the evolutionary processes of polyploidy, hybridization, and ecological/geographic isolation that have occurred in the base-5 asters. From southwestern diploid ancestors have arisen wide-ranging tetraploids with subsequent divergence in the Appalachian and Ozarkian regions, and the production of a high polyploid with a unresolved ancestry. Additional studies are planned in order to develop a better understanding of the biology and relationships of the taxa in *Aster* section *Patentes*.

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A NEW SPECIES OF *FIMBRISTYLIS* (CYPERACEAE) FROM THE SANDSTONE AND GRANITIC OUTCROPS OF ALABAMA AND GEORGIA

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ABSTRACT

Fimbristylis brevivaginata, a new species of perennial fimbristyloid sedge endemic to sandstone and granitic glades in northeastern Alabama and piedmont Georgia, is diagnosed, described, and figured. Differences between it and its closest morphological relatives, *F. puberula* (Michx.) Vahl (vars.) and *F. caroliniana* (Lam.) Fern., are given.

INTRODUCTION

In the 1960s, during the process of annotating loans of *Fimbristylis* toward completion of a treatment of the genus for North America (Kral 1971), I encountered two samples of a perennial *Fimbristylis* from granite glades of the Georgia piedmont which were particularly hard to place. These, one from around the base of Little Stone Mountain in DeKalb County (*J.K. Small*, 25 Jul 1893, GH, UC), and the other from Hancock County to the east (*R. McVaugh 5338*, GH, UC), are of identical morphology, though separated within the granite outcrop archipelago by more than 50 miles. Tentatively, I placed the two under *F. puberula*, determining to relocate populations for a more definitive study. A visit to the McVaugh locality in 1967 proved to be productive, the locality (3 mi SE of Sparta) appearing little changed from how McVaugh must have found it. A decade later I was able to locate another larger population in Rockdale County a short distance northwest of Millstead, Georgia. Morphologies of the three then-known populations appeared remarkably consistent. During these years I had occasion to revisit Georgia piedmont granites a number of times on other work, keeping an eye out for such plants there, but finding none. I concluded, perhaps rightly, that this particular *Fimbristylis* was rare within that region and deferred the problem unwisely. In 1980 I was surprised to find the same *Fimbristylis* on a sandstone bluff overlooking the Little River in Alabama and was thus stimulated to look further for these plants in similar habitats there and elsewhere in northern Alabama. Such attempts to find other populations within this spatially and geologically different region have thus far been unsuccessful. However, given the added impetus of being assigned to do *Fimbristylis* for FNA, and having been

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convinced of the morphological and ecological distinctness of this plant, I hereby describe it.

Fimbristylis brevivaginata Kral, sp. nov. Fig. 1.

Fimbristylis brevivaginata, sp. nov.; a *F. puberula* (Michx.) Vahl et vars. foliorum ligulis completis, laminis complanatis, angustioribus, a *F. caroliniana* (Lam.) Fern. scapis angustioris, culmorum basibus bulbosis, spiculis pubescentioribus, ab ambobus habitibus brevioribus, foliorum brevioribus, rhizomatibus fasciculatis, squamis spiraliter imbricatis, valde contractis et attenuatis.

Bulbous-based cespitose perennial 2 – 5 dm high from scaly, thickened-based, short, attenuate rhizomes. Young culms sub-cormose, forming from axillary buds, emerging from chaffy and fibrillose old leaf bases as short, spirally imbricate-scaly rhizome, the short, red-brown rhizomal scales grading longer uprhizome, passing to foliage leaves, these gradually longer-bladed, from cuspidate to longer, the principal ones (-5)10 – 17(-20) cm long; sheaths of principal leaves dilated, multicostate, ecarinate, with broad, multicostate bases and broad, scarious, distally fimbrio-ciliate borders, mostly less than l/5 as long as blades, at junction with them producing a complete, transverse, pale-ciliolate ligule; blades narrowly linear, firm, flat, level or shallowly concave, 1.5 – 2.5 mm wide, tapering gradually to an abruptly acute, often apiculate tip, margins intermittently scabro-ciliate, incrassate, pale, surfaces pale green, the upper coarsely 7 – 10-costate at midblade, the lower finely longitudinally striate-nerved. Scapes slender, slightly to very compressed, ca. 1 mm broad, coarsely costate, lateral ones often remotely scabrid distally; anthela mostly simple, of 2 – 7 spikelets, the slender, smooth, multicostate rays ca. 0.5 mm wide, mostly broadly ascending around the sessile spike, and from 0.5 – 6.0 cm long, surpassing the primary involucre; primary involucre of 3 – 4 bladed bracts, the longest mostly 1 – 3 cm long, their sheaths ciliate, convex, multicostate, costae sometimes sparsely hirtellous, subtending angulately tubular hirtellous prophylls 4 – 5 mm long, the secondary involucres mostly lacking; spikelets narrowly ovoid to lanceoloid or cylindric, 5 – 15 mm long, acute to blunt, red-brown, scales tightly spirally imbricate, red-brown, broadly ovate, convex, smooth to puberulent, the lower ones sterile, all ranging 4.5 – 5.0 mm long, the lower ones cuspidate, becoming mucronate distally; fertile scales medially 3 – 5-costate, the central nerve strongest, on lower scales short-excurrent, costal area on younger spikes often green; anthers 3, linear, ca. 2 mm long; style-base flat, linear, ca. 2 mm long, the 2 divaricate, excurved branches ca. 1 mm long; stylar apex and branch-bases fimbriate. Fruit obovoid-lenticular, ca. 1.2 – 1.5 mm long, the convex faces each with 11 – 13 ribs, dark brown to greenish-brown with lustrous tints, ribs connected by transversely oriented rows of shallow, narrowly rectangular alveolae, fruit edges somewhat umbonate, pale, apex with a short, truncate apiculus.

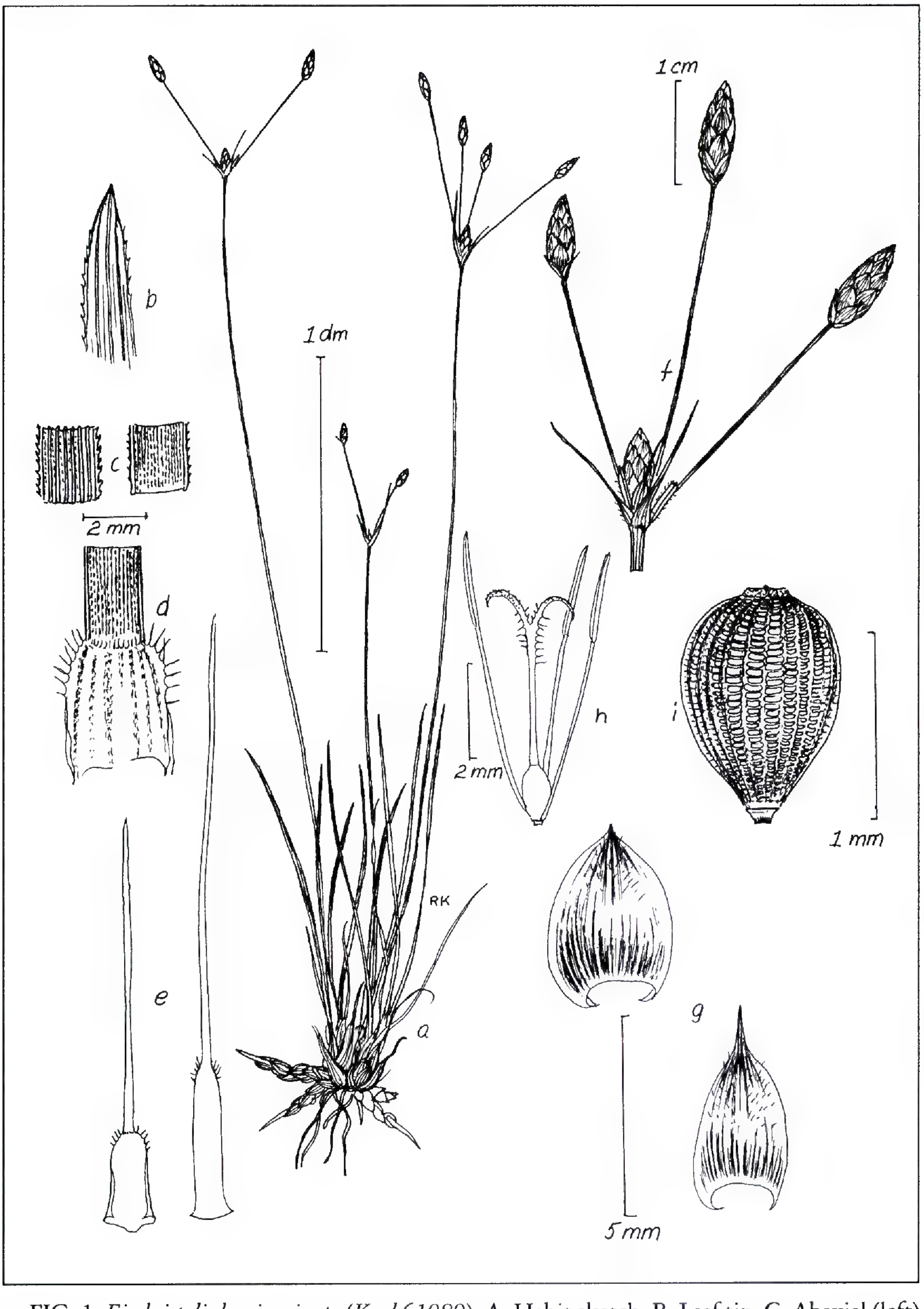

FIG. 1. *Fimbristylis brevivaginata* (*Kral 61089*). A. Habit sketch. B. Leaf tip. C. Abaxial (left) and adaxial (right) sides of leaf midblade. D. Leaf blade-sheath junction, adaxial side. E. Idealized outlines of two principal leaves. F. Inflorescence. G. Fertile scales, at right one from downspike, above one from upspike. H. Floret. I. Fruit.

In full sun around shallow pools, rivulets or humus-packed moist fissures in sandstones or granites, very local in the Cumberland Plateau of Alabama (DeKalb Co.) and in the Piedmont of Georgia, flowering intermittently from late spring to fall with peaks in June and September.

TYPE: U.S.A. GEORGIA. **Rockdale Co.:** several patches on shallow moist to wet soils over granite outcrop, ca. 2 mi NW Millstead off hwy GA 20, 23 Sep 1977, *R. Kral 61089* (HOLOTYPE: BRIT; ISOTYPES (FSU, GA, GH, MICH, NCU, NY, PH, RSA, TENN, US, VDB).

Additional specimens examined: ALABAMA. **DeKalb Co.:** sandrock outcrops above Little River, Canyon Parkway 1.4 mi S of jct hwy AL 35, seeps, 24 Sep 1980, *R. Kral 66381* (VDB); 9 Jun 1981, *67405* (GH, BRIT, VDB); 28 Jul 1981, *67609* (AUA, GH, US, VDB). GEORGIA. **DeKalb Co.:** about base of Little Stone Mountain, 25 Jul 1893, *J.K. Small, s.n.* (GH, UC); **Gwinett Co.:** ca. 1.9 mi SSE Snellville, above E bank of No Business Creek, S of Springdale Drive (Co. rd 364); large doming gneiss outcrop, relatively undisturbed areas S of powerlines, moist sandy flats, 3 Nov 1983, *J.R. Allison 1927* (GA); **Hancock Co.:** shallow soils about granite outcrops 3 mi SE of Sparta, 26 Aug 1940, *R. McVaugh 5338* (GH, UC); ca. 4 mi SE Sparta along hwy GA 15, moist sandy peaty flat depressions in granite outcrop area, 28 Jul 1967, *R.Kral 28705* (GH, BRIT, US, VDB); ca. 3.5 mi SE Sparta, 4.9 mi SSW Culverton, ca. 2 mi W jct with Co. rd 178 and GA 15, scattered granite exposures in woods N of P-185, 24 Sep 1986, *J.R. Allison with M.J. Murphy 2788* (GA); **Rockdale Co.:** in thin soil on granite outcrop 2 mi N of Conyers, 800 ft el., 14 May 1948, *A. Cronquist 5184* (GA); granite dome, more tree than shrub than most, few open pools, on Panola Mt., 17 Jul 1971, *A.M. Evans et al. 45744* (TENN, VDB); **Walton Co.:** 3.75 mi NW Walnut Grove, "Rock of the Ages," huge gneiss flatrock astride Rocky Branch E of Rabbit Farm Rd., (Co. rd 95), 4 Jul 1984, *J.R. Allison 2340*; ca. 5.5 mi SSW of Loganville, 1.95 mi SSW of crossing of Little Haynes Creek by Center Hill Church Rd. Lithonia (granite-) Gneiss flatrock, W side of Black Shoals Rd (Sharon Church Rd.), 0.15 mi due W of jct Miller Bottom Rd, 8 Jun 1989, *J.R. Allison 3852* (VDB).

As was indicated in the diagnosis and description, this plant shows characters of both *F. puberula* and *F. caroliniana*, differing from the former by its flatter leaf blades and its completely developed ligule, and from the latter by its more compact, shorter, more strongly fascicled, tapering rhizomes; its more bulbous culm bases; its more compact, shorter, more strongly fascicled, tapering rhizomes; its more bulbous culm bases; its narrower scape; and its hairier spikelets. It is distinguished from both species by its consistently lower habit, its much more contracted leaf sheaths and its mode of rhizome development.

While both varieties of *F. puberula* produce rhizomes, those of var. *puberula* are thick, short, and untapered, cloaked by tightly ascending imbricate rows of chaffy remains of older primary leaf sheaths. Thus each rhizomal node has its "bud" or "bulb," each erect in orientation and each developing a bulbous-based culm with erect or ascending leaves with narrow, mostly involute blades. By contrast, a rhizomal shoots of *F. brevivaginata* is itself a strongly tapering, horizontally-oriented bud whose tip becomes the vertically-oriented leafy culm with leaf blades that are distinctly flattened and broader. The other variety of *F. puberula*, var. *interior*, of sandy prairie swales far to the west in the plains of Nebraska, Kansas and Texas indeed produces fascicles of horizontally disposed rhizomes, but these,

while tending to be short and scaly, are distinctly more slender, more contorted, and lack taper. This variety is similar in leaf to var. *puberula*, having narrow, involute, eligulate blades.

Fimbristylis caroliniana has much the same rhizome development as *F. puberula interior* but these rhizomes are longer, thicker. Their leaves are flatter and have complete ligules, thus more resembling *F. brevivaginata*. But *F. caroliniana* is taller, broader-scaped, usually has more spikelets on a more flattened, wider scape, and forms extensive clones much different than the cespitose habit displayed by the rest of the complex. In any case, the relationships of *F. brevivaginata* to *F. caroliniana* is of less consequence here simply because of its very different geography and habitat, the latter being confined mostly to coastal situations and more basic substrata.

The outcrops to which *F. brevivaginata* appears confined are sometimes shared by other fimbristyloids, most notably the annuals *F. annua* (All.) R. & S. and *F. autumnalis* (L.) R. & S., which are unrelated. When this manuscript was submitted I had no information about occurrence of any other perennial *Fimbristylis* on granites or sandstones within the same localities *F. brevivaginata* grows. Recently, however, two specimens of *F. puberula* var. *puberula* have been donated to VDB by Mr. James R. Allison that were collected by him from granites in Georgia, one from Harris County (*Allison 3185*) and one from Muscogee County (*Allison 3961*). Both these counties are at or toward the southwestern limit of Piedmont granites in Georgia, at or near the Fall Line. Such evidence, though scanty, supports the idea that the widespread "matrix" species, from which *F. brevivaginata* likely arose, is in this case *F. puberula*, particularly its variety *puberula*. It is nearest morphologically and spatially. The taxonomy is close, but it is consistent for species of, and speciation within, *Fimbristylis*.

ACKNOWLEDGMENTS

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REFERENCE

KRAL, R. 1971. A treatment of *Abildgaardia*, *Bulbostylis*, and *Fimbristylis* (Cyperaceae) for North America. Sida 4(2):57 – 227.

THE GENUS *NYSSA* (CORNACEAE) IN NORTH AMERICA: A REVISION

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ABSTRACT

The genus *Nyssa* has been the subject of bibliographic and taxonomic confusion for more than two centuries. This revisionary research reviews the nomenclatural history, ecological research, and certain evolutionary relationships of the genus. In an associated study that combined foliar flavonoids with traditional taxonomic exomorphic features, habit, and habitat characteristics of the North American *Nyssa*, a distinct monophyly for five taxa was revealed. A clarification of species separation between *N. sylvatica* and *N. biflora* is expanded to include habitat and morphological features. A new key, new species descriptions, and recently compiled distribution maps of the five North American *Nyssa* species also are presented. The five North American *Nyssa* taxa are: *Nyssa aquatica* L., *N. biflora* Walt., *N. ogeche* Bartr. ex Marsh., *N. sylvatica* Marsh., and *N. ursina* Small.

INTRODUCTION

A number of major taxonomic problems have occurred throughout the systematic history of North American members of the genus *Nyssa* (Rickett 1945; Eyde 1959; 1963; 1966). Some of the problems have been associated with difficulties in correlating species with habitats while other problems have involved the synonymy of the genus. Many authors have recognized at least two morphological varieties of *Nyssa sylvatica* Marsh. in which the two most variant forms have been associated with either lowland hydric or upland mesic habitats. Other authors have recognized as many as four varieties of *N. sylvatica*.

The systematic delineations also have been questionable with regard to the *Nyssa biflora* Walt. and *N. ursina* Small correlation. Some authors have considered *N. ursina* to be a separate species (Small 1927; Rickett 1945; Clewell 1985), while other authors have considered it to be an ecologically induced variant of *N. biflora* or *N. sylvatica* var. *biflora* (Kurz & Godfrey 1962; Eyde 1966; Godfrey & Wooton 1981; Godfrey 1988).

Certain taxonomic and bibliographic problems have occurred with *Nyssa ogeche* Bartr. ex Marsh. and *N. acuminata* Small. It is now generally agreed that *N. acuminata* is only a phenotypic variation of *N. ogeche* (Eyles 1941; Little 1979) induced by ecologically stressful situations primarily produced by fire (Eyde 1966) and/or drought.

In many herbaria, a problem exists in that *Nyssa aquatica* L. often is separated

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from *N. uniflora* Wangenh. Eyde (1964a) appears to have clarified the nomenclatural problems and *N. aquatica* usually is recognized as having nomenclatural precedence and synonomy with N. *uniflora*.

Close taxonomic and phylogenetic affinities long have been recognized between *Nyssa* and *Cornus* and, although *Nyssa* is the genus under examination in this research, *Cornus* is discussed with regard to phylogenetic outgroup comparison. Also, the genus *Garrya* has been associated with both *Nyssa* and *Cornus* (Holm 1909; Moseley & Beeks 1955; Eyde 1964b) and, therefore, *Garrya lindheimeri* Torr. is discussed.

Due to the lack of availability of material, the disjunct populations of *Nyssa sylvatica* in Mexico were not examined for flavonoids. However, the traditional morphological characters and the distribution of *N. sylvatica* in Mexico were examined from numerous herbarium specimens.

PREVIOUS WORK

Nomenclature of the Genus

First cited in *Systema Naturae* (Linnaeus 1735), the name *Nyssa* was applied to a genus but no species were recognized (Eyde 1959). In *Species Plantarum*, Linnaeus (1753) recognized one species, *N. aquatica*, that had been determined from several specimens of both *N. aquatica* and *N. sylvatica* (Eyde 1964a). Other authors would later determine that this species was a *nomen confusum* (Rickett 1945; Eyde 1964a). For at least the next two centuries, nomenclatural controversy was to become very common for members of the genus *Nyssa*.

In 1785, Humphrey Marshall published his recognition of *Nyssa sylvatica* (Little 1979), although Thomas Walter (1788) independently described the same species as *N. multiflora* only three years later. Also in 1785, Marshall published the name *N. ogeche* (Little 1979), which William Bartram had assigned to that taxon but had never validly published. Bartram referred to it as *N. coccinea*. Friederich von Wangenheim (1787) published his account of *N. uniflora*, but this name has been placed in synonomy under *N. aquatica* (Eyde 1964a).

In 1788, Walter was the first to recognize *Nyssa biflora* as a separate species. Walter (1788) also described *N. multiflora*, as mentioned above, *N. capitata*, which is synonymous with *N. ogeche*, and supported von Wangenheim's *N. uniflora*. Nine years later, Jean de Lamarck published Jean Poiret's description of *N. caroliniana*, now another synonym for *N. sylvatica* (Rickett 1945; Little 1979).

In 1893, C. S. Sargent lowered *Nyssa biflora* to varietal status under *N. sylvatica* (Eyde 1963), and twelve years later elevated it back to *N. biflora*. In 1903, J.K. Small published his account of *N. acuminata* (Small 1903), which today is recognized only as an ecological variant of *N. ogeche* (Eyde 1966; Little 1979).

The most recent publication of a new tupelo species was *Nyssa ursina* (Small 1927). Small published the description three years after collecting numerous

specimens near Port St. Joe, Florida. Many authors have failed to recognize *N. ursina* as a true species. Rather, they have viewed it only as a phenotypic variant of either *N. sylvatica* var. *biflora* or *N. biflora* (Kurz & Godfrey 1962; Eyde 1966; Godfrey & Wooton 1981).

Many other varieties of *Nyssa* have been published, although today none of those varieties are generally accepted by botanists other than *N. sylvatica* var. *biflora*. Other varieties of *N. sylvatica* include var. *caroliniana*, var. *dilatata*, and var. *typica* (Fernald 1935; 1950). In 1878, Sereno Watson published the synonym *N. multiflora* var. *sylvatica* (Rickett 1945).

Theodore Holm (1909) reviewed root, stem, and leaf features of *Nyssa sylvatica*. Holm also cited his recognition of three species of *Nyssa* in North America, and their affinities to *Cornus* and *Garrya*.

A problem with leaf dentation variability in *Nyssa sylvatica* has encouraged some authors to recognize varieties *caroliniana* and *dilatata* (Fernald 1935; 1950; Steyermark 1963). However, Holm observed that dentation did not depend upon the positions of the leaves on the tree. Rather, leaf dentation appeared to occur more frequently on young trees and, on older trees, there appeared to be no order to the degree of dentation. Holm also was impressed by the variability of leaves in *N. sylvatica* as being almost as striking as the heterophylly in *Sassafras* (Holm 1909).

Although common names vary greatly in usage (Jones & Luchsinger 1986), the name "tupelo" has been applied to all species of *Nyssa* at various times in the literature. Most frequently, the name "water tupelo" has been referred to *N. aquatica*; "swamp tupelo" has been referred to *N. biflora*; "ogeche-lime" to *N. ogeche*; "dwarf tupelo" to *N. ursina*; and "blackgum," "sourgum," "pepperidge," or "black tupelo" to *N. sylvatica*. Unfortunately, some of the names have been used to refer to more than one species, and some of the names have been liberally interchanged among the species.

In this century, the first significant systematic effort that delineated *Nyssa* was completed by Rickett (1945). Rickett compiled the most thorough synonomy of the North American species, but tended toward splitting the group and thus recognized *N. sylvatica*, *N. biflora*, *N. ursina*, *N. uniflora*, *N. ogeche*, and *N. acuminata*. Little (1979) also compiled a recent synonomy of the North American species.

The most comprehensive systematic work of the genus was a survey of all known extant *Nyssa* species (Eyde 1963) in which Eyde detailed species characteristics and distributions. Eyde & Barghoorn (1963) also reviewed species characteristics, phylogenetic affinities, and nomenclatural synonomies of the extinct nyssoids. In a review of the taxa of the southeastern United States, Eyde suggested *N. biflora* deserved varietal status, because the differences that separated it from *N. sylvatica* were not as great as those that distinguished undisputed

species of *Nyssa* (Eyde 1966). Also, he suggested that others may want to treat *N. biflora* as a subspecies.

In Clark's *Woody Plants of Alabama* (1971), three species and one variety of *Nyssa* are recognized: *N. aquatica*, *N. sylvatica*, *N. ogeche*, and *N. sylvatica* var. *biflora*. Clark acknowledged Eyde's citation of *N. ogeche* occurring in Alabama, but observed that no Alabama specimens had been examined. Clark stated that *Nyssa* taxa are very wide-ranging and variable and *N. biflora* appears to deserve ecotypic status. While reviewing some of Clark's specimens, many that had been identified as *N. sylvatica* var. *biflora* were annotated as *N. sylvatica*.

In a recent publication (Eyde 1988), extensive evidence was given for the replacement of *Nyssa* into the Cornaceae. Eyde believed that the Nyssaceae had been accidentally and erroneously separated from the Cornaceae (Wangerin 1907; 1910), and that Wangerin probably would have corrected the error, if not for his untimely death (Eyde 1988). Likewise, Eyde probably would have further promoted returning *Nyssa* to Cornaceae, if not for his untimely death.

Many features commonly cited as supporting separation of Nyssaceae and Cornaceae recently have been compromised by related genera exhibiting characteristics of both families. Many of these cornaceous genera were unknown by Wangerin, due to their rarity of collection and remoteness of location (Eyde 1988). In addition to at least two species of *Cornus* having alternate leaf arrangement (a feature shared with *Nyssa*), *Mastixia*, *Davidia*, and *Camptotheca* share many features intermediate between *Cornus* and *Nyssa* (Eyde 1963). Also, the recent recognition and placement of the "fossil" *Diplopanax* into subfamily Mastixioidae of Cornaceae, contributes yet another genus that exhibits characters between *Cornus* and *Nyssa* (Eyde & Qiuyun 1990). Therefore, this research means to encourage the replacement of *Nyssa* into the Cornaceae.

Ecological Research

Over the past five decades, much research has been published about the genus *Nyssa* regarding ecological, environmental, developmental, and phytosociological variables. Many studies appear to have been motivated by lumbering interests because those works review the difficulties encountered in reaching pure stands of *Nyssa* and problems involving regeneration and growth of large stands.

Two articles that examined the frequency of distribution and quantity of *Nyssa* and associated taxa, also cited observations on water quality, ratios of particulate matter to water at varying depths, and hydrogen ion concentrations of water in tupelo swamps in Louisiana and Alabama (Hall & Penfound 1939; 1943). Another study examined comparative wood structure in tupelo "knees" (Penfound 1934).

Nyssa sylvatica was used as an indicator plant in determining relative cobalt concentrations within various soil types (Kubota et al. 1960). The authors found

that high concentrations of cobalt in soil are transmitted to high concentrations in the leaves of *N. sylvatica*. Although *Nyssa* was not known to be a forage plant of cattle, low concentrations of cobalt in *Nyssa* were translated to represent a nutritional deficiency of cobalt in cattle.

A large amount of tupelo research has centered on flood tolerance and physiological adaptations of *Nyssa* in floodplain and swamp habitats. Many of those studies made comparisons between aquatic *Nyssa* species and other lowland or aquatic tree taxa (Gill 1970; Hook & Brown 1973; Keeley 1979; Donovan et al. 1988).

A study of soil and site factors affecting the growth of tupelo stands in southeastern Georgia (Applequist 1959) was another project encouraged by lumbering concerns. The objectives of the research were to correlate soil and site factors to the quality and quantity of growth and yield. Applequist found that growth and development of *Nyssa biflora*, *N. aquatica*, and *Taxodium distichum* are dependent primarily upon large quantities of water. The evidence suggested that these three species not only tolerate extensive flooding, but actually thrive on it.

Associated with Applequist's research was his particularly significant citation of many species-specific characteristics of the species of *Nyssa*. Although he recognized that taxonomic problems existed in the literature, Applequist established an independent list of character differences. Applequist found *N. biflora* to have narrower and more oblanceolate leaves than *N. sylvatica*. He observed that fruits were borne singly or in pairs on *N. biflora* and in clusters on *N. sylvatica*. Also, he recognized that *N. biflora* occurred only in wet sites, whereas *N. sylvatica* occurred from lowland to upland sites, but never in inundated locations. Applequist's most novel observation was that the flowers of *N. biflora* appear after the leaves are fully developed, whereas the flowers of *N. sylvatica* appear before full leaf development.

A brief study of oxygen requirements for germination of *Nyssa aquatica* seeds, showed that seeds would not germinate in continually flooded habitats (Shunk 1939). Further research on germination rates of tupelo seeds compared four different soil/water regimes (DeBell & Naylor 1972). In the second study, it was found that germination was most rapid in moist, then drained regimes, and that no germination occurred in soil that remained continually under water. However, germination did occur under water in the absence of soil.

A recent study of germination, regeneration, and growth rates of *Nyssa aquatica* compared three microhabitat substrate types and analyzed species establishment on the various substrates (Huenneke & Sharitz 1990). Germination occurred only rarely in completely submerged substrates. On emergent substrates, germination had the highest rate, but seed predation and erosional scour counteracted the germination rate and greatly lowered survivability. Although germination rates were lower on microhabitats of adjoining flooded

and emergent substrates, seed predation was very low, erosional scour was ineffective, and the accumulation of a true soil demonstrated the greatest overall survivability of tupelo seedlings.

Another recent study compared successional effects between floodplain sites disturbed by thermal discharge and undisturbed sites (Muzika et al. 1987). Above-ground biomass and primary production were found to be greater in both the undisturbed riverine (floodplain) and stream habitats. Dominant taxa in the undisturbed habitats were *Taxodium distichum* and *Nyssa aquatica*. In the disturbed (or "recovering") habitats, *Salix caroliniana* and *Acer rubrum* were the dominant species. Biomass accumulation ratios were five to twenty times greater in the undisturbed habitats than in the disturbed habitats. The effects of thermal discharge were elimination of the floodplain vegetation and, even after 15 years of recovery, low biomass productivity that implied a general lack of habitat recovery.

A significant study of net biomass and population differentiation showed consistently variant physiological adaptations between upland, floodplain, and swamp populations of *Nyssa sylvatica* and *N. sylvatica* var. *biflora* (Keeley 1977; 1979). Keeley found that upland plants (*N. sylvatica*) were very intolerant of flooded soils. Much physiological deterioration occurred and survival rates were very poor after a year of flooded conditions. In comparison, the swamp plants [*N. biflora*] were very tolerant of flooded conditions reflected by high survival rates. Adaptations included the production of new roots which exhibited an increased capacity for alcohol fermentation. In contrast, floodplain plants [*N. sylvatica*] in drained conditions allocated more biomass to the shoots than to the roots, along with other traits similar to upland plants. However, under flooded conditions, the floodplain plants increased oxygen transport to the roots and had higher survival rates than the upland plants under flooded conditions.

Keeley concluded that the intermediate floodplain plants produced two ecologically induced phenotypes which were adaptable to, and had high survival rates for, either the upland or swamp conditions. Yet the similarities between upland and floodplain populations appeared to be greater than the similarities between floodplain and swamp populations. In recent research that examined the flavonoids and phylogenetics of the North American *Nyssa* (Burckhalter 1990), one of the conclusions was that upland and floodplain populations constitute *N. sylvatica* while swamp populations constitute *N. biflora*.

Flavonoids and Phylogenetics

Chromatographic extraction and UV spectral analysis of the flavonoids from North American *Nyssa* revealed a total of 10 different flavonoid compounds. The compounds were isolated from 114 specimens of *Nyssa* and seven specimens of *Cornus* (Burckhalter 1990). All compounds, that were isolated from three

different species of *Cornus*, also occurred in *Nyssa*. In addition, six flavonoid compounds were isolated from one specimen of *Garrya*. With only one exception, all compounds from *Garrya* were more distantly related biochemically to the flavonoids isolated in both *Nyssa* and *Cornus* (Burckhalter 1990).

A multistate database was established using traditional morphological characters from 1290 specimens of *Nyssa*, 459 specimens of *Cornus*, and 24 specimens of *Garrya lindheimeri*. In addition, presence/absence of the flavonoids from all 122 specimens of *Nyssa*, *Cornus*, and *Garrya* were added to the database. Regardless of various adjustments of the data, all cladograms always revealed that *Nyssa* and *Cornus* were sister groups, that all five taxa of *Nyssa* were distinct taxa, and that all five taxa always displayed the same phylogenetic relationships within the genus (Burckhalter 1990).

The four types of flavonoid compounds isolated from *Nyssa* and *Cornus* were quercetin, quercetin glycosides, kaempferol, and kaempferol glycosides. Most compounds isolated from *Garrya* were apigenin and apigenin glycosides. Perhaps the single most outstanding characteristic among the flavonoids of *Nyssa* was a consistent occurrence of a quercetin glycoside in all 37 populations of *N. sylvatica*. In contrast, that glycoside never occurred in the 28 populations examined of *N. biflora*. Further, a kaempferol glycoside occurred in all populations of *N. biflora* that never occurred in *N. sylvatica* (Burckhalter 1990). Details of the flavonoids and phylogenetics will appear in a separate paper.

DISCUSSION

Status of *Nyssa sylvatica* and *Nyssa biflora*

Since the question of species separation between *Nyssa sylvatica* and *N. biflora* may be considered to be the greatest problem during the bibliographic history of the genus *Nyssa*, additional effort was pursued in examining species status for those two taxa. That effort was coordinated by reviewing characteristics of *N. sylvatica* that had been collected in moist lowland sites.

Variation in response to habitat or species hybridization long have been suggested as the reasons for similarity between *Nyssa biflora* and *N. sylvatica*. Frequently, it has been suggested that *N. biflora* is an aquatic or moist lowland variety of *N. sylvatica* (Eyde 1963; 1966; Little 1979; Godfrey & Wooton 1981; Godfrey 1988).

Nyssa sylvatica occurs in a much wider range of habitats than *N. biflora*. *Nyssa sylvatica* may be found from upland xeric localities to moist lowlands occasionally under water inundation. *Nyssa biflora* is restricted to truly aquatic habitats and occasionally marginally aquatic environments. Rarely, the habitats of the two species overlap. Usually the leaves of lowland *N. sylvatica* will be more narrow than leaves of nearby upland individuals. However, populations have been found where there is no apparent difference in leaf morphology between habitats. This

may lead to confusion when collecting sterile specimens, since *N. biflora* normally has more narrow leaves.

In its northern extremes, for example Maine, Ontario, and Michigan, the habitat of *Nyssa sylvatica* tends to be low moist ground near swamps or lake margins (Otis 1931; Fernald 1950). Regardless, the leaves usually are wide and large, and the fruits normally are in multiples of three or more. Of many carpellate specimens examined, most appeared to have a reduced spikate-like peduncle. In review of 65 herbarium specimens from extreme northern locations, in Maine, Michigan, and Ontario, it was found that most were from low moist areas. The one collection from Canada used in the flavonoid and phylogenetics research (Burckhalter 1990) was made in a woodlot in moist rich flatwoods on sandy soil.

Flavonoid results from eight moist lowland site populations of *Nyssa sylvatica* demonstrated that this species may become established in extremely stressful and undesirable habitats, to which the species may, or may not, well adjust. The more similar leaf morphologies to *N. biflora*, combined with the occasional unhealthy appearance of the tree, gives support to genotypic plasticity resistance regardless of environmental limitations.

The flavonoid evidence from all of the lowland site *Nyssa sylvatica* collections indicated that *N. sylvatica* and *N. biflora* unquestionably are separate species (Burckhalter 1990). Without biochemical knowledge of the speciation between *N. sylvatica* and *N. biflora*, both Applequist (1959) and Keeley (1977, 1979) supported separate speciation for the two taxa in their research involving growth and development, and flooding tolerances.

Evolutionary relationships within *Nyssa*

Flavonoid, mophological, and cladistic analyses clearly delineate five taxa of *Nyssa* in North America (Burckhalter 1990). With *Cornus* as the outgroup, *Nyssa* was found to be the sister group to *Cornus*. As a result of the cladistic analyses, it may be speculated that *N. sylvatica* shares a lineage with an unknown ancestor that gave rise to the other four species of North American *Nyssa*. That unknown ancestor then gave rise to the two lineages which separate the *N. biflora* - *N. ursina* complex and the *N. aquatica* - *N. ogeche* complex (Fig. 1).

As may be compared with the characteristics of fossil nyssoids (Eyde & Barghoorn 1963), *Nyssa sylvatica* appears to be more similar to the fossil record of the Tertiary than the other four North American taxa of *Nyssa*. Eyde (1963) was led to the conclusion that *N. sylvatica* was the most similar extant North American *Nyssa* to the ancestral nyssoids.

Exomorphic characteristics represent closer relationships between *Nyssa biflora*, *N. ursina*, and *N. sylvatica* than between *N. aquatica*, *N ogeche*, and *N. sylvatica*. Both *N. aquatica* and *N. ogeche* exhibit many more derived characters,

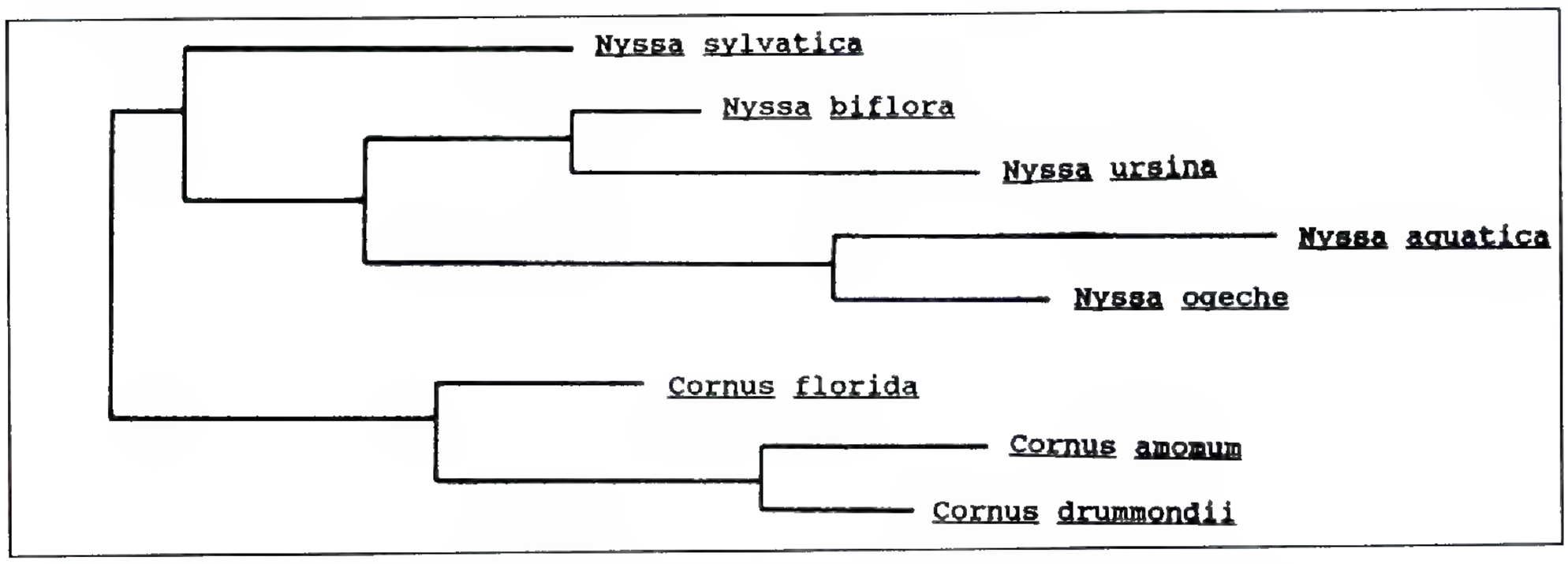

FIG. 1. Cladogram of North American *Nyssa* with *Cornus* as the Outgroup.

such as large fruits, single fruits per peduncle, and large leaves, than the more plesiomorphic *N. sylvatica*, *N. biflora*, and *N. ursina* (Burckhalter 1990).

Although the occurrence of specific flavonoid compounds was highly consistent within all populations of a given taxon, the presence and/or absence of specific compounds varied greatly between taxa. Efforts at determining evolutionary relationships from only the flavonoids, excluding exomorphic characteristics, were not significant. Those efforts included examining evolutionary biochemical pathways and presence/absence applied to phylogenetic analysis. Further discussion will appear in a separate paper.

Specimens for distribution maps

This research includes new distribution maps of the five species of *Nyssa* in Anglo-America. The maps have been compiled by a review of nearly 7100 specimens from herbaria throughout the central, eastern, and southern United States. Figures 2 through 6 represent county locations of specimens from naturally occurring populations for all five North American *Nyssa* taxa. The county representations were taken from the herbarium collections. Some specimen information was correlated with county collections cited in four publications covering certain geographical regions. Those publications include citations for specimen locations in Arkansas (Smith 1988), Georgia (Jones & Coile 1988), Missouri (Steyermark 1963), and North Carolina and South Carolina (Radford et al. 1968). Most of those specimen locations were repetitious with locations observed in the various herbarium specimens.

Only three sources are known that have published distribution maps for the entire range of the North American and/or Anglo-American species of *Nyssa* (Fernald 1935; Eyde 1963; Little 1971). Since the time of those publications, much additional distribution information has been accumulating in the form of herbarium specimens. Unfortunately, there are specimens which have not been viewed for inclusion into the new distribution maps. Nearly 400 specimens from GA were unavailable for review due to an extended loan to another institution.

Key to the Species

1. Trees; lowland to upland habitats; fruits in clusters usually 4 or 5 ..... *Nyssa sylvatica*
1. Trees or shrubs; very moist habitats, swamps, usually inundated; fruits 1 or 2 per peduncle 2
   2. Leaves narrowly lanceolate, entire, usually 3 – 14 cm long; fruits usually 2 per peduncle; mature fruit blue-black, 0.6 – 1.4 cm long 3
   2. Leaves widely ovate to obovate, often dentate toward apex, usually 8 – 25 c long; fruits usually 1 per peduncle; mature fruit olive green to orange to light brown, 2 – 4 cm long 4
   3. Trees; leaves 5 – 14 cm long; fruit oblong, peduncle 1 – 4 cm long ..... *Nyssa biflora*
   3. Shrubs; leaves 3 – 6 cm long; fruit globose, peduncle 0.5 – 2 cm long .... *Nyssa ursina*
      4. Leaves widely obovate, often dentate toward apex, 10 – 25 cm long, petiole 2 – 5 cm long; mature fruit olive green to brown ..... *Nyssa aquatica*
      4. Leaves narrowly to widely ovate, occasionally dentate throughout, 8 – 18 cm long, petiole 0.5 – 1.5 cm long; mature fruit dull yellow to orange ..... *Nyssa ogeche*

Species Descriptions and Distributions

Nyssa aquatica L., Sp. Pl. 1053. 1753; pro parte.

Nyssa uniflora Wangenh., Betyr. Teutsch. Fortstwiss. Nordam. Holz. 83, pl. 27, fig. 57. 1787.
Nyssa denticulata Aiton, Hort. Kew. 3:446. 1789.
Nyssa palustris Salisb., Prodr. Stirp. Chap. Allerton 175. 1796.
Nyssa angulisans Michx., Fl. Bor.-Amer. 2:259. 1803.
Nyssa tomentosa Michx., Fl. Bor.-Amer. 2:259. 1803.
Nyssa grandidentata Michx. f., Hist. Arbr. Forest. 2:252. 1813.
Nyssa denticulata Pursh, Fl. Amer. Sept. 1:178. 1814.
Nyssa candicans var. *grandidentata* D.J. Browne, Trees America 426. 1857.

Description: Trees aquatic, dioecious, seldom-branching, to 35 m tall; trunks usually buttressed. Leaves widely ovate to obovate, 10 – 25 cm long, 5 – 10 cm wide, the margins often dentate toward apex; petiole 2 – 5 cm long. Carpellate inflorescence usually imperfect, occasionally with sterile stamens, flower solitary and sessile, peduncle 2 – 5 cm long. Staminate inflorescence, imperfect, racemose to compact spikate to head-like to umbellate. Fruit dull yellow to olive green to light brown, oblong, 2 – 3 cm long.

Distribution: Occurrence of *Nyssa aquatica* (Fig. 2) is occasional to common throughout the Coastal Plain from southeastern Virginia, through the eastern Carolinas, central and southern Georgia, the western Florida panhandle, into southern and western Alabama. It is common throughout Mississippi, Louisiana, and eastern Arkansas. It is common also in localized portions of eastern Texas, southeastern Missouri, extreme southern Illinois, and western Tennessee. Being out of the typical Coastal Plain province, *N. aquatica* also may be found along upper reaches of the Tennessee River, in northeastern Alabama and south central Tennessee, and into the Arkansas River valley of west central Arkansas.

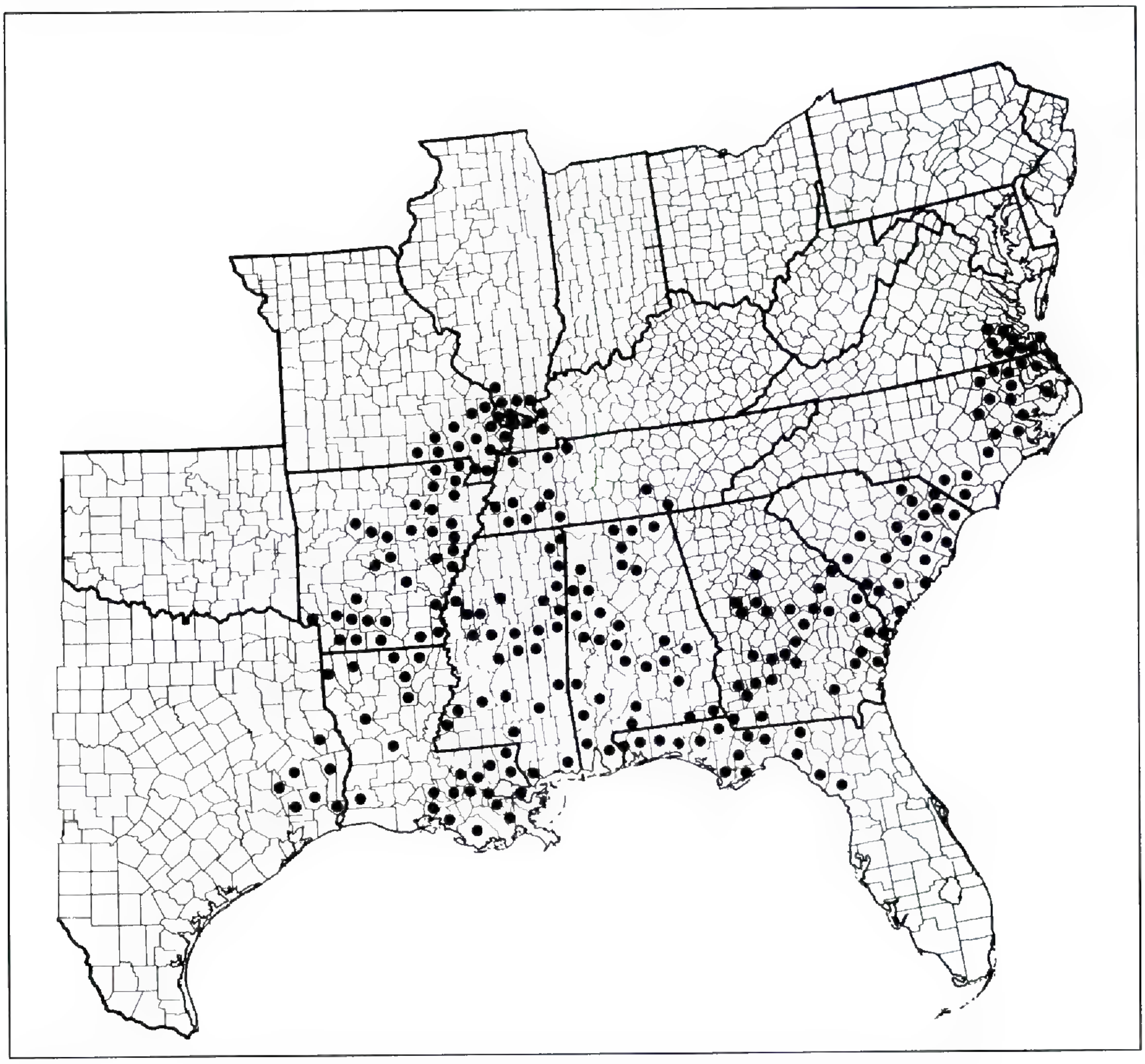

FIG. 2. *Nyssa aquatica*. Documented distribution by county in the United States.

Nyssa aquatica occurs primarily in swamps, along riverbanks, and occasionally in low moist floodplains. It may be found commonly in nearly monospecific colonies of very large trees in inundated swamps. *Nyssa biflora* or *Taxodium distichum* frequently are found growing with *N. aquatica*. One specimen collected in Duval County, Florida (Little 1971), has been redetermined to be *N. ogeche*. The occurrence of *N. aquatica* in east central Illinois is doubtful.

Nyssa biflora Walter, Fl. Carol. 253. 1788. *Nyssa sylvatica* var. *biflora* (Walter) Sarg., Sylva 5:76, pl. 218. 1893. *Nyssa sylvatica* ssp. *biflora* (Walter) E. Murray.

Nyssa servatilis E.H.L. Krause, Beih. Bot. Centr. 32:333. 1914.

Description: Trees aquatic, dioecious, seldom-branching, to 25 m tall, trunks usually buttressed. Leaves usually narrowly lanceolate, 5 – 14 cm long, 1.5 – 4 cm wide, often somewhat coriaceous with recurved margins, apex often rounded; petiole 0.5 – 1.5 cm long. Carpellate inflorescence usually imperfect, occasionally with sterile stamens, flowers usually in pairs, occasionally 1 or 3, sessile or

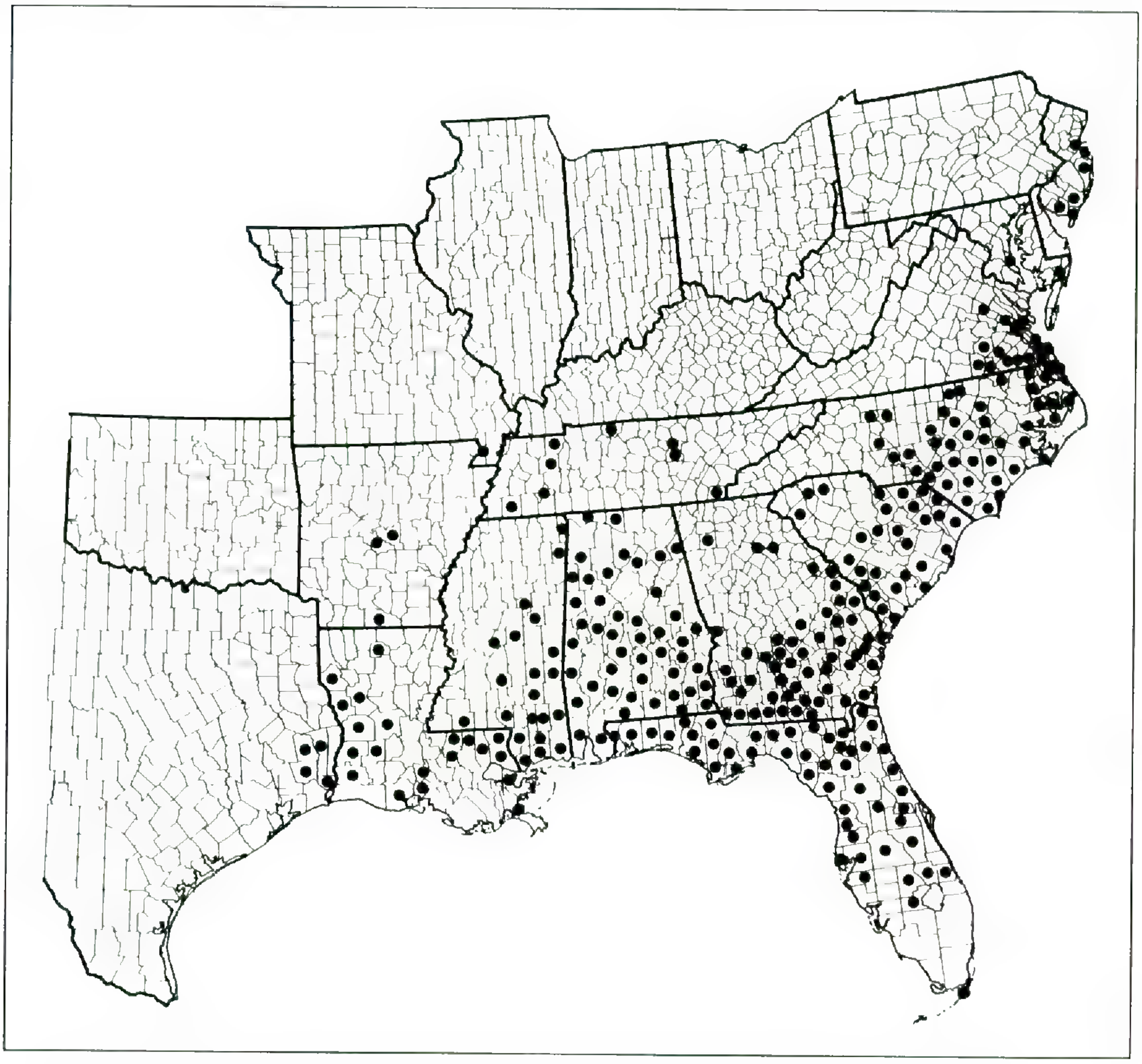

FIG. 3. *Nyssa biflora*. Documented distribution by county in the United States.

pedicellate, peduncle 1 – 4 cm long. Staminate inflorescence imperfect, racemose to compact spikate to umbellate. Stamens arising from margins of numerous, often pedicellate, circular pads. Fruit dark blue to black, ovoid, 0.7 – 1.4 cm long.

Distribution: Occurrence of *Nyssa biflora* (Fig. 3) is occasional to common throughout the Coastal Plain from central New Jersey to southeastern Texas. It is very common in inundated acidic swamps, and occasionally along low moist riverbanks or pond margins, from east central North Carolina to central Mississippi. Occurrence in northern Georgia, northern Alabama, central Tennessee, and southeastern Arkansas is very sporadic, but again, associated with inundated acidic swamps. *Nyssa biflora* often occurs in monospecific colonies or associated with *N. aquatica* or *Taxodium distichum*.

One collection originally identified as *Nyssa ursina*, attributed to J.K. Small from Lignumvitae Key, Monroe County, Florida (Long & Lakela 1971), has been redetermined to be *N. biflora*. Despite numerous attempts by various people to

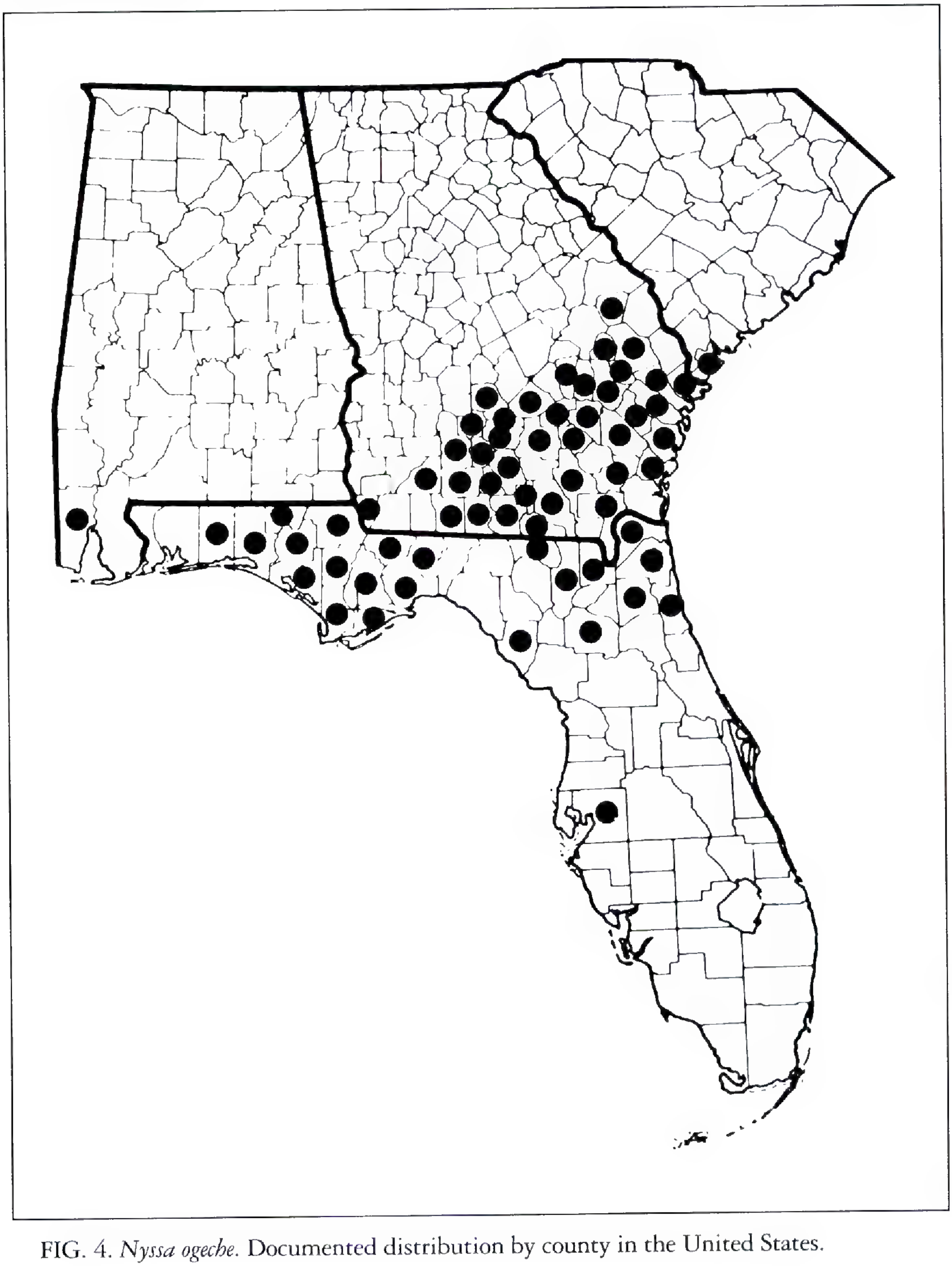

FIG. 4. *Nyssa ogeche*. Documented distribution by county in the United States.

relocate the occurrence of *N. biflora* in the Florida Keys, no recent collections have been made. It is questionable that *N. biflora* was collected in the Florida Keys due to a mis-labelling of Small's collection (Ward & Craighead 1990). Previously unknown populations of *N. biflora* were found in February and March 1992 in southern Okeechobee County, Florida.

Nyssa ogeche Bartram ex Marshall, Arbust. Amer. 97. 1785.

Nyssa coccinea Bartram, nom. nud.
Nyssa captiata Walter, Fl. Carol. 253. 1788.
Nyssa tomentosa Poir. in Lam., Encycl. 4:508. 1797.
Nyssa candicans Michx., Fl. Bor.-Amer. 2:259. 1803.
Nyssa oye-chee Steud., Nomencl. Bot. 558. 1821.
Nyssa acuminata Small, Fl. S.E. U.S. 852. 1903. *Nyssa ogeche* var. *acuminata* (Small) Eyles, Castanea 6:35. 1941.

Description: Large shrubs to small trees, aquatic, dioecious, usually 5 – 8 m tall, rarely to 12 m; numerous trunks arising from swollen base. Leaves usually widely lanceolate to ovate or with rounded tips, often with recurved margins and pubescent on underside, 8 – 18 cm long, 3 – 8 cm wide; petiole 0.5 – 1.5 cm long. Carpellate inflorescence occasionally imperfect, frequently with stamens, solitary and sessile, peduncle 0.5 – 2 cm long. Staminate inflorescence, imperfect, racemose to compact spikate to head-like to umbellate. Fruit dull yellow to olive brown to orange, oblong, 2 – 4 cm long.

Distribution: *Nyssa ogeche* (Fig. 4) occurs almost entirely in southeastern Georgia and northern Florida. It is known also from Beaufort County, South Carolina. Although this species is restricted to a relatively small geographical area, it is very common throughout much of its range. It commonly occurs in sandy-bottom swamps, bogs, along low riverbanks, and in deep-water swamps, where it may be associated with *N. biflora*. In many river swamps of southeastern Georgia and west central Florida, especially along the Apalachicola River, this species may be nearly monospecific.

One report of *Nyssa ogeche* was made from a Charles Mohr specimen collected in Mobile County, Alabama in 1890 (Eyde 1963), but in review of that specimen, it has been redetermined as *N. aquatica*. However, Mohr did not recognize this species to occur in Alabama (Mohr 1901). A second specimen collected by Mohr in Mobile County in 1892; was identified by Mohr as *N. uniflora*, but it was recently annotated as *N. ogeche* (Eyde pers. comm.). This is the only known specimen of *N. ogeche* from Alabama.

Nyssa ogeche has been expected to occur in extreme southeast Alabama, but no known collection exists. It occurs in adjacent counties in both Georgia and Florida. Extensive field work in Houston County, Alabama in 1988 and 1989 failed in locating *N. ogeche*.

Cultivated specimens of *Nyssa ogeche* are known from Hillsborough Co. Florida, Lake Co. Florida, and Orange Co. North Carolina. A second population of *N. ogeche* in Hillsborough County appears to be a naturally occurring spontaneous population.

Nyssa ogeche is the species from which honey is gathered, along the Apalachicola River in Florida, to produce the very high quality tupelo honey of legend and literature (Eyde 1963).

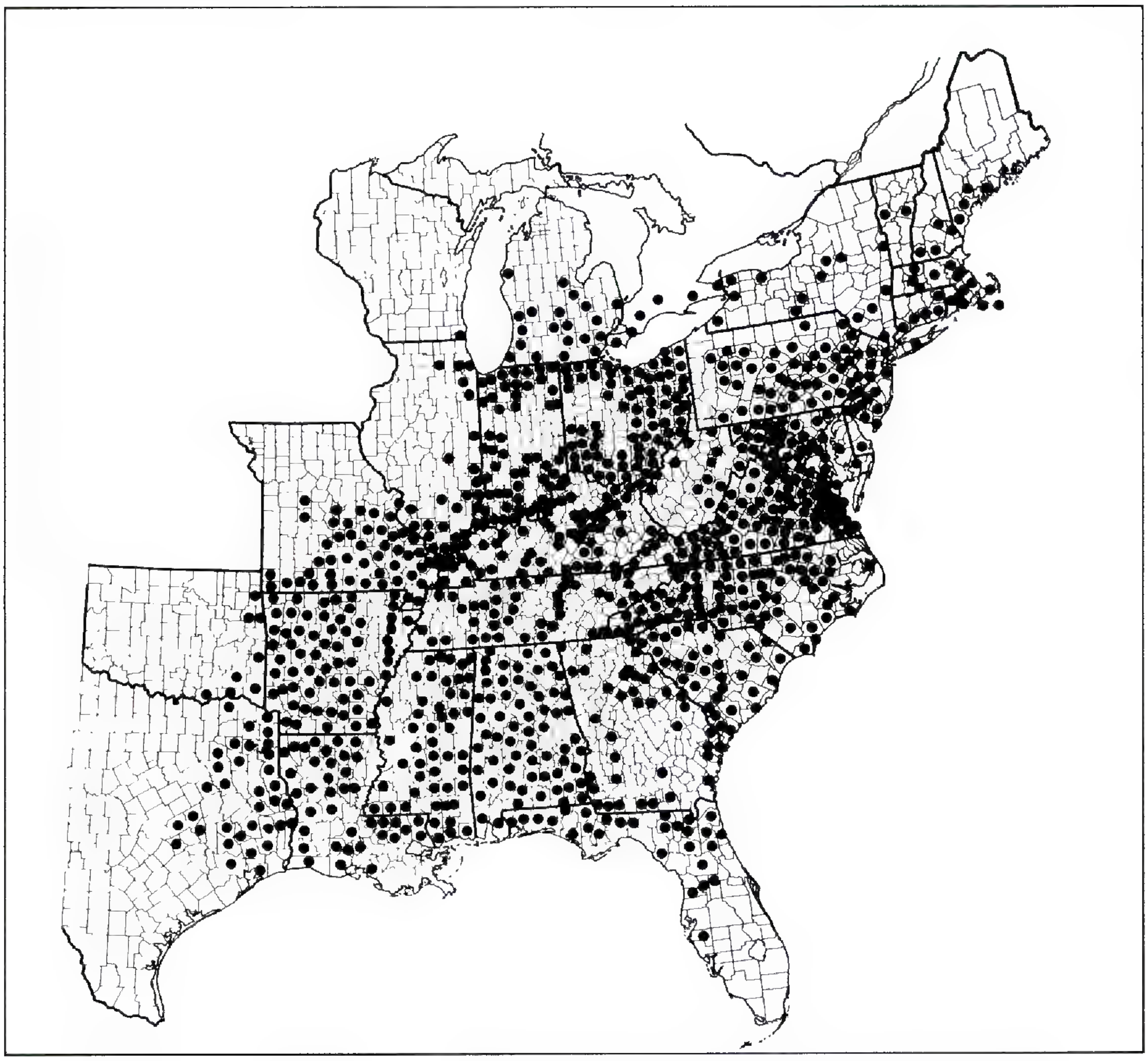

FIG. 5. *Nyssa sylvatica*. Documented distribution by county in the United States.

Nyssa sylvatica Marshall, Arbust. Amer. 97. 1785. *Nyssa multiflora* var. *sylvatica* (Marshall) S. Wats., Bibl. Index N. Amer. Bot. 442. 1878.

(*Nyssa aquatica* L. Sp. Pl. 1058. 1753; pro parte.)
Nyssa multiflora Wangenh., Beytr. Nordam. Holz. 46. 1787.
Nyssa integrifolia Aiton, Hortus Kew. 3:446. 1789.
Nyssa angulosa Poir. in Lam., Encycl. 4:507. 1797.
Nyssa canadensis Poir. in Lam., Encycl. 4:507. 1797.
Nyssa caroliniana Poir. in Lam., Encycl. 4:507. 1797. *Nyssa sylvatica* var. *caroliniana* (Poir.) Fern. Rhodora 37:436. 1935.
Nyssa villosa Michx., Fl. Bor.-Amer. 2:258. 1803.
Nyssa montana Hort., Michx., Fl. Bor.-Amer. 2:258. 1803.
Nyssa integrifolia glauca Hort., Pers., Syn. Pl. 2:614. 1807.
Nyssa ciliata Raf., Atlantic J. 176. 1833.
Nyssa sylvatica var. *aquatica* Sarg., Gard. & Forest 2:435. 1889.
Nyssa sylvatica var. *typica* Fern., Rhodora 37:434. 1935.
Nyssa sylvatica var. *dilatata* Fern., Rhodora 37:436. 1935.

Description: Trees terrestrial, dioecious, frequent-branching, to 30 m tall; trunks never buttressed, occasionally slightly expanded; limbs often arising from trunk at right angles. Leaves greatly variable from narrowly lanceolate to widely ovate to widely obovate, 6 – 18 cm long, 3 – 8 cm wide, narrow leaves never dentate, wide leaves often dentate toward apex; petiole 0.5 – 3 cm long. Carpellate inflorescence usually imperfect, occasionally with sterile stamens, usually 3 – 9 flowers, occasionally 2 in upland habitats, sessile or pedicellate, racemose to compact spikate to head-like, peduncle 1.5 – 4 cm long. Staminate inflorescence imperfect, racemose to compact spikate to head-like to umbellate. Stamens arising from margins of numerous, often pedicellate, circular pads. Fruit dark blue to black, ovoid, 0.8 – 1.8 cm long.

Distribution: *Nyssa sylvatica* (Fig. 5) occurs from southern Maine, across New York and southern Ontario, to central Michigan. It occurs sporadically across Illinois, and commonly across central Missouri to eastern Oklahoma and east central Texas. This species may be found near the Gulf Coast from eastern Texas to northern Florida, yet uncommon in the lower Mississippi River delta. It occurs occasionally into central Florida, but very commonly along the Eastern Seaboard to southern Maine. Although not included on the distribution map, disjunct populations of *N. sylvatica* are known from the Mexican states of Chiapas, Hidalgo, Puebla, and Veracruz (Miranda 1945; Eyde 1963; 1966).

An interesting coincidence is the great similarity between the geographical distributions of *Nyssa sylvatica* and *Cornus florida* (Little 1971). It may be uncommon to find two arborescent taxa within the same family with such a wide ranging geographical similarity.

The habitat of *Nyssa sylvatica* varies greatly from low moist woods to mesophytic or xerophytic upland woods. *Nyssa sylvatica* appears to prefer acidic soils rather than alkaline limestones. As a result, the species is not very common across central Kentucky or the Black Belt of Mississippi and Alabama. It is very common in well-drained upland habitats with poor soils. It may be found as a very common component of oak-hickory-pine woods. *Nyssa sylvatica* is considered to be a dominant tree species in the southern Appalachian Mountains (Whittaker 1956).

Nyssa sylvatica also occurs in lowland habitats, and this distribution often has been determined erroneously as indicating *N. sylvatica* var. *biflora*. Lowland *N. sylvatica* may have narrow leaves nearly identical with *N. biflora*, but a combination of other characters (multiple inflorescence, non-buttressed trunk, non-inundated habitat) is virtual assurance that the species is lowland *N. sylvatica*.

The few specimens of *Nyssa sylvatica* (at US) that were collected in eastern Kansas during the 1880s and 1890s are considered to have been made from cultivated trees.

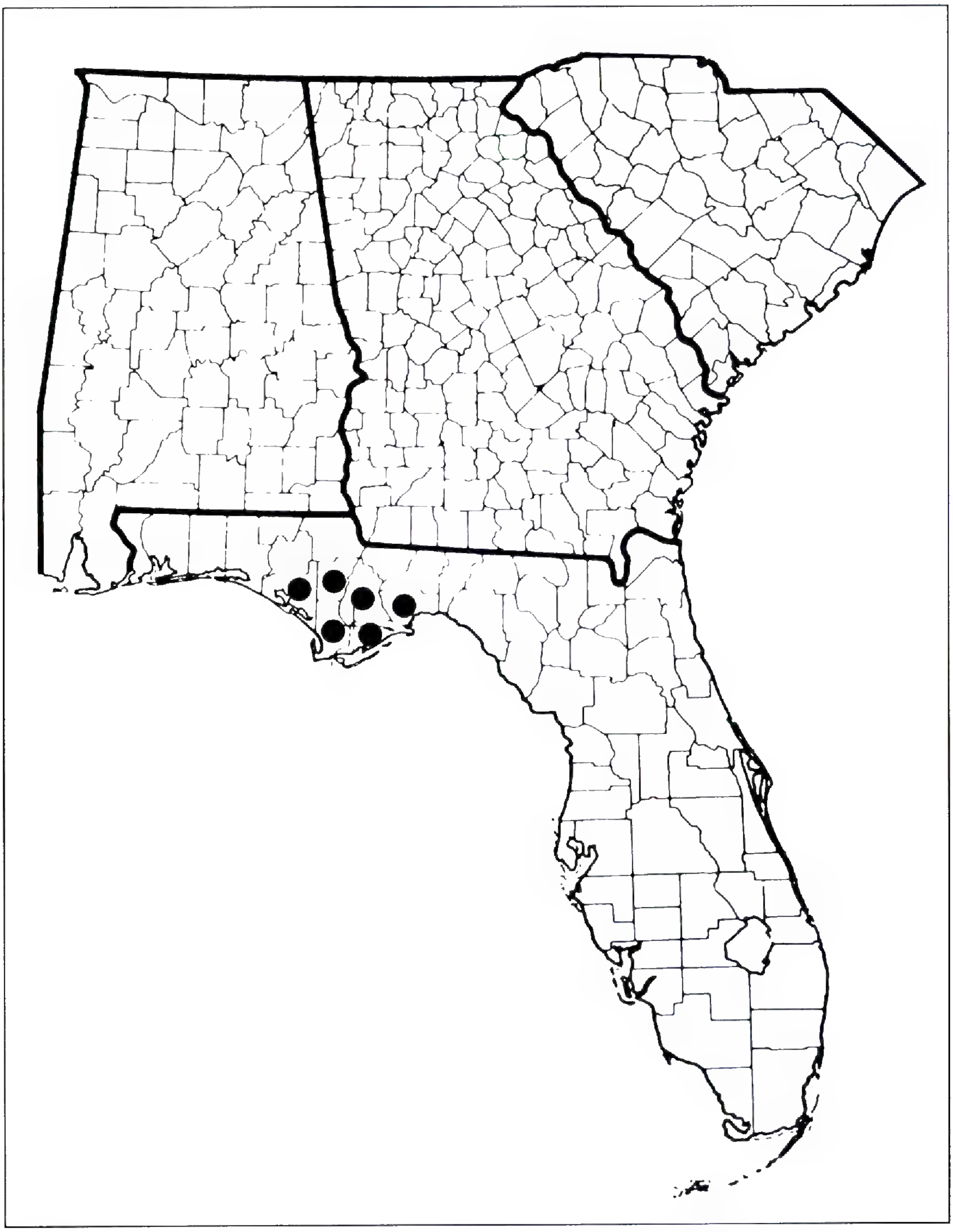

FIG. 6. *Nyssa ursina*. Documented distribution by county in the United States.

Nyssa ursina Small, Torreya 27:92. 1927.

Description: Shrubs or small trees, aquatic, usually to 3 m tall, occasionally to 5 m; trunks expanded to buttressed. Leaves narrowly lanceolate, 3 – 6 cm long, 1 – 2 cm wide; petiole 0.3 – 1 cm long. Carpellate inflorescence usually imperfect, occasionally with sterile stamens, flowers usually in pairs, rarely 1 or 3, sessile or

pedicellate, peduncle 0.5 – 2 cm long. Staminate inflorescence imperfect, racemose to compact spikate to head-like to umbellate. Stamen clusters arising from margins of numerous, often pedicellate, circular pads. Fruit dark blue to black, globose, 0.6 – 1 cm long.

Distribution: *Nyssa ursina* (Fig. 6) appears to occur in only six counties in west central Florida associated with the Apalachicola and Ochlockonee Rivers. At least one author has considered *N. ursina* to be a component of the remnant refugium of the Apalachicola River area (Clewell 1977). Three specimens from southeastern Georgia (at NCU) identified as *N. ursina* have been redetermined to be *N. biflora*. The specimens from Lignumvitae Key, Florida, collected by J. K. Small and believed to be *N. ursina* (Eyde 1963), also have been redetermined to be *N. biflora*.

The typical habitat for *Nyssa ursina* is very low moist ground where it is uncommon to abundant in low moist flatwoods but common in inundated swamps and sloughs. The entire region of its habitat is very low in elevation above sea level. Many authors consider this species to be a variety of *N. biflora*, but locations have been seen where both species occur within one half kilometer of each other, and both species exhibit their own specific characteristics.

A 1991 specimen collected by J.R. Burkhalter in Escambia County, Florida appears to be *Nyssa ursina* and may represent a new disjunct location for the species. Further research into this population is anticipated.

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NOTES

CHRONOLOGY OF THE NATURAL RANGE EXPANSION OF *TILLANDSIA RECURVATA* (BROMELIACEAE) IN TEXAS[1]—The expanding range of a native plant can indicate local or regional changes in the environ-ment or changes in the dispersal of the species or both. The chronology of a range expansion may provide some insight into the complex interacting factors that allow a species to expand its range.

The present study describes the chronology of the range expansion (Fig. 1) of *Tillandsia recurvata* L., ball-moss, in Texas through 1977. *Tillandsia* species are specialized epiphytes or saxicoles. They are usually xerophytes and in the case of *T. recurvata* the plants are sensitive to freezing particularly when they are moist (Hagar 1990). Detailed considerations of historical phytogeography require an explicit knowledge of the historical range of the taxa. Fortunately, Birge (1911) mapped the known distribution of ball-moss in Texas. Although her map probably did not include all extant populations, it certainly reflected the general distribution of the species to 1910 when the work was completed. Literature and herbarium specimens from the early 1900s support the restriction of the plant to central Texas, an area having 50 to 75 cm of precipitation per year. Both Birge's map and herbarium specimens from the turn of the century show that the plant reached its eastern limits in Bell Co, central Milam Co., Lee Co. and further south in Lavaca Co. and northern Victoria Co. A similar range was defined by specimens cited by Smith (1944). The species was not listed for either Harris Co. or Brazos Co., two areas where it is common today and areas that were well known to botanists in 1911. In terms of longitude, the historical range of the species in Texas as mostly west of the meridian at 97 degrees and 45 minutes.

In 1942, *Tillandsia recurvata* was first collected (*R.G. Reeves 1916*, TAES) in Brazos County about 56 km east of its previously known range. The plant was very rare in the county (pers. comm., R.G. Reeves, John Sperry and Homer Blackhurst). In 1972, I was able to find the species in the county only at the Washington Church where Reeves had collected it in 1942. However, in subsequent years, various collectors observed the species at over 100 locations in the county. In 1964 *T. recurvata* was collected slightly east of the "Birge" line in Calhoun Co. (*D.S. Correll 26171* (TEX)).

By 1989 *Tillandsia recurvata* had been recorded or collected from 18 counties in Texas east or slightly north of its range in 1911 as well from new locations in other states. The following Texas collections of *T. recurvata* are deposited in the

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[1]Technical publication 30871 from the Texas Agricultural Experiment Station.

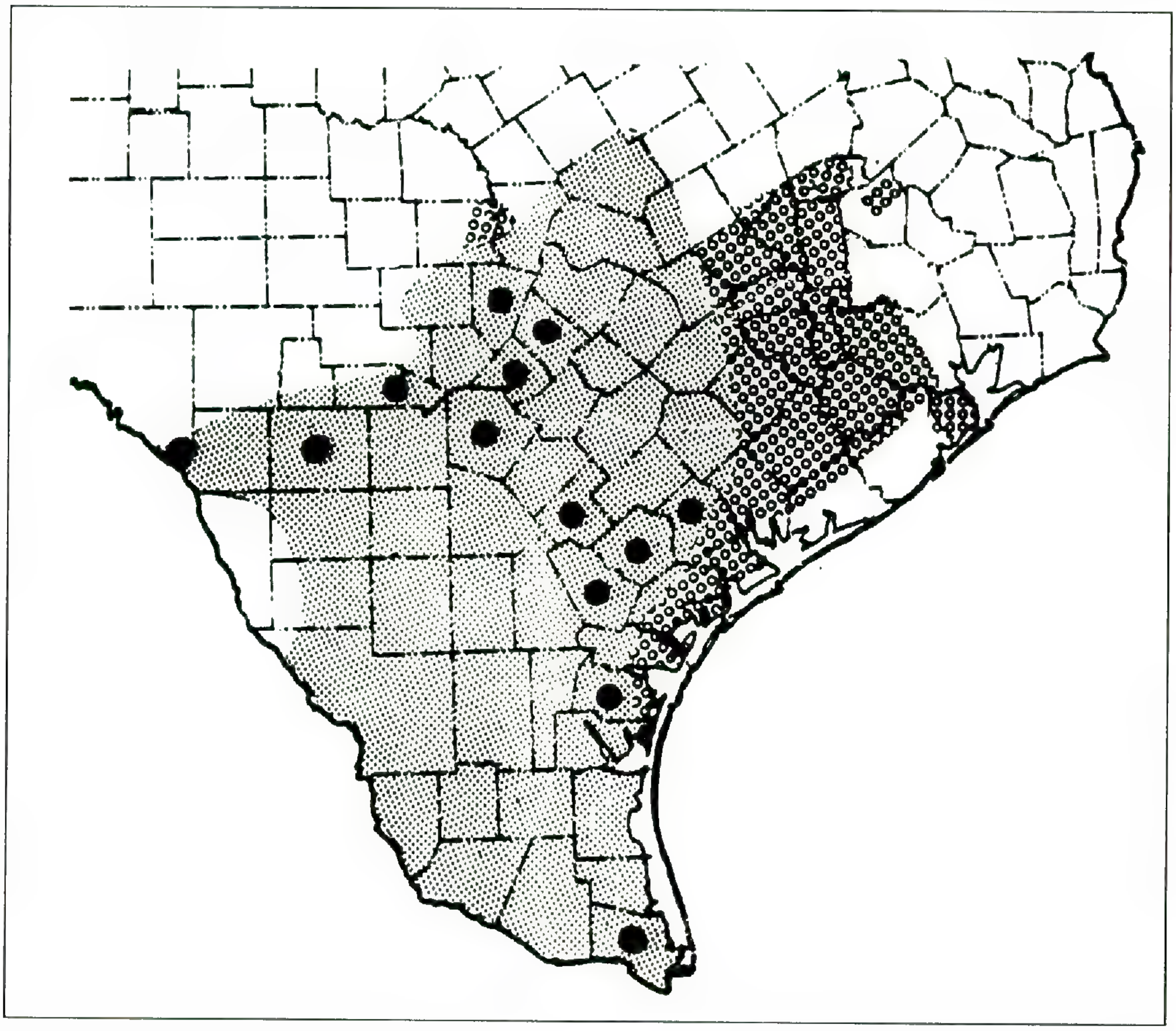

FIG. 1. Documented distribution of *Tillandsia recurvata* in South and South Central Texas: Grey shading: distribution in Birge (1911); Black dots: distribution in Smith (1948); Open circles: present distribution in natural (non-urban areas).

TAES Herbarium, except as noted, and collected outside the range defined by Birge in 1911:

TEXAS: **Aransas Co.**: *Sue Gardener 603* (TAMU); **Austin Co.**: large populations found in rural areas of the county, *E.L. McWilliams 1974-5*; **Brazoria Co.**: *E.L. McWilliams,* photogaph only; **Brazos Co.**: found throughout the highland areas of the county by 1977; **Burleson Co.**: *E.L. McWilliams 1974-2*; **Burnet Co.**: *E.L. McWilliams 1977-11*, 1977-12; **Fort Bend Co.**: *E.L. McWilliams 1974-9*; **Galveston Co.**: rare, *E.L. McWilliams 1977-33*; **Grimes Co.**: widespread, *E.L McWilliams 1977-1*; **Harris Co.**: *E.L. McWilliams, 1976-5*; **Jackson Co.**: *E.L. McWilliams 1977-18*; **Llano Co.**: *Ellen Horlen s.n.*, 1977; **Matagorda Co.**: *E.L. McWilliams 77-22;* **Robertson Co.**: rural plants only seen in southern half of county, photograph only; **Waller Co.**: *E.L. McWilliams* 1977-25; **Walker Co.**: scattered in the Huntsville area, *John Meyer s.n.* (SHST); **Washington Co.**: common, *E.L. McWilliams 1977-44*; **Wharton Co.**: *E.L. McWilliams 1977-24.*

The northern geographical limits defined by Birge were studied in 1977 and specimens of the plant were found in southern but not northern Bell Co. as indicated by Birge in 1911.

These records indicate that the range of ball-moss has expanded along a wide band over 100 kms. eastward or northeastward between 1911 and 1977. Moreover, the species is currently found in many locations where it had not been encountered in 1972. However, as indicated by the herbarium specimen chronology, most of the expansion took place after 1942 and before 1978. One urban population was seen in Trinity Co. but no rural plants could be found in the eastern section of the county despite efforts by several collectors to locate new populations. The plants found in Trinity Co. were at least 5 years old, and the age of the plants did not indicate that the site had only recently been colonized. Thus, it appears that the new geographical range limits of *Tillandsia recurvata* stabilized in the 1980s.

The long distance dispersal of *Tillandsia recurvata* as a result of human activities is common in Texas and other states. The species has long been cultivated, is sometimes an epiphyte on woody landscape plants, and is sold as an oddity, and used in floral wreaths and other Christmas decorations. Cultivated populations of the species are not cited in this study. One example of long distance dispersal by man known to be of horticultural origin was a population on a single tree collected by Chris Hagar in 1988 near White Rock Lake in Dallas. Field observations and the large completely rural populations that occur in the counties listed here clearly indicate that natural wind dispersal is highly effective in dispersing the plant.

While the present distribution of *Tillandsia recurvata* has expanded significantly to the east and northeast, the present range differs little from the 1911 distribution in the northern part of its range. Two exceptions to this pattern are along the shores of Lake Buchanan in Burnet and Llano Cos. and the upper reaches of Lake Amistad in Val Verde Co. It is hypothesized that the lakes have modified the local mesoclimate and allowed the epiphyte to extend its range in trees and on rocks near the shores of the lakes.

In summary, county records for *Tillandsia recurvata* are reported for 18 counties in south central and east Texas east or northeast of where the species was known to occur in 1911. Populations of the plant have grown in size in previously marginal sites over the last 80 years. Changes in the geographical range of this epiphyte are potentially important since *Tillandsia* spp. are known to be sensitive to environmental changes in both moisture and minimum temperatures.

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I thank Dr. R.Q. Landers, Dr. Lyman B. Smith and Prof. Claude McLeod and

for their assistance during this study.—*Edward McWilliams, Department of Horticultural Sciences, TAMU, College Station, TX 77843, U.S.A.*

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ABOUT *LUPINUS CUMICOLA* (FABACEAE)—Isely (1990) combines *L. cumicola* Small with *L. diffusus* Nutt. stating that the former "represents peninsular Florida forms that have strongly ascending, foliose stems and sometimes broader leaves than the usual type." We point out that there are at least six consistent significant differences besides height which we present below.

Lupinus cumicola vs. Lupinus diffusus

(1) Legumes (pods) mostly 27 – 42 mm long by 8.1 – 8.5 mm across* and broadly linear vs. mostly 35 – 47 mm by 6.3 – 7.6 mm and oblong.
(2) No partitions between mature seeds vs. thin partitions between seeds.
(3) Depressions on legume between seeds obscured by hairs vs. depressions evident.
(4) Hairs on pods to ca. 3 mm long, rusty-tannish, and loose woolly vs. hairs to ca. 2 mm long, light brown, silky, and mostly somewhat appressed and parallel with each other.
(5) Living plants silvery and to 1.9 m tall including inflorescences vs. grayish-green and to 0.7 m tall including inflorescences.
(6) Principal stem of seedlings continuing erect growth for as much as 28 cm before developing ascending branches vs. only a short vertical growth before developing prominent prostrate branches that ascend only at ends.
*Note: Pods appear even larger as hairs are more spreading than in *Lupinus diffusus*.

Plants of both species occur near Winterhaven, Polk, Co., Florida and consistently exhibit these differences. We maintain that such differences warrant *Lupinus cumicola* being maintained at species level as is done by Small (1933). Our conclusions are based mostly on studies of 42 herbarium specimens (GA) of *L. diffusus* from Alabama, Florida, Georgia, Mississippi, North Carolina, and South Carolina, 10 specimens (GA) of *L. cumicola* from Florida and abundant field observations in Florida, Georgia, and South Carolina, including ca. 20 popula-

tions of the latter species.—*Wilbur H. Duncan, Department of Botany, University of Georgia, Athens, GA 30602, U.S.A. and Robert B. McCartney, Woodlanders, 1129 Colleton Ave., Aiken, SC 29801, U.S.A.*

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MANIHOT SUBSPICATA (EUPHORBIACEAE) NEW TO TEXAS—Shrublands on caliche bluffs and slopes in Jim Wells, Live Oak, and San Patricio Counties, Texas, are known to harbor populations of several plant species which, although variously distributed in northeastern Mexico, are otherwise absent from Texas. Species represented in Texas by such disjunct populations include *Caesalpinia phyllanthoides* Standl., *Cassia greggii* Gray, and *Boerhavia mathisiana* F. B. Jones.

A recent collection indicates that *Manihot subspicata* Rogers & Appan might be added to this list. This shrub, known from the Mexican states of Coahuila, Nuevo Leon, and Tamaulipas (Rogers & Appan 1973), was collected in Jim Wells County at the Live Oak County line on the W side of Lake Corpus Christi. Two shrubs were seen at this site and a third shrub was encountered but not vouchered less than 1 km to the N in Live Oak County. Both sites are on dissected slopes where caliche of the Goliad Formation (Miocene) is exposed. Soils at the Jim Wells County site are mapped as shallow, well drained, droughty, moderately alkaline, grayish brown gravelly loam Petrocalcic Calciustolls of the Olmos association over undulating terrain (Minzenmayer 1979). No published soil survey is available for Live Oak County. Vegetation at both sites is a relatively undisturbed mixed evergreen/deciduous shrubland dominated by *Leucophyllum frutescens* (Berl.) I.M. Johnst., *Acacia berlandieri* Benth., *A. rigidula* Benth., *Calliandra conferta* Benth. ex Gray, and *Cassia greggii* Gray.

Manihot subspicata was not reported from Texas in Correll & Johnston (1970) or its update (Johnston 1990), or from the Texas Coastal Bend area in Jones (1977) or its update (Hill 1982). The question of the nativity of this taxon in Texas was immediately raised but will never be answered. While it is our opinion that this population is native to this interesting area, the simple fact that this conspicuous shrub has not been previously reported from a well botanized region of Texas suggests that *Manihot subspicata* may be a recent introduction.

Flowering specimens of this taxon will key in Correll & Johnston to the genus

Manihot, which is otherwise represented in Texas by *M. walkerae* Croizat. *Manihot subspicata* can be distinguished at once from *M. walkerae* on the basis of habit alone: *M. walkerae* is (in Texas) a herbaceous plant with trailing stems, whereas *M. subspicata* is a woody shrub with numerous erect albeit slender stems at least 1 m tall. A complete description of *M. subspicata* is provided in Rogers & Appan (1973).

The assistance and interest of Mark Mayfield, Dr. Billie Turner, and others at the Herbarium of the University of Texas at Austin, as well as Ruth O'Brien of the Corpus Christi Museum, are gratefully acknowledged.

Voucher specimen: TEXAS. **Jim Wells Co.**: W side of Boat Ramp Rd, 0.2 mi S of Trail Ridge Rd, W side of Lake Corpus Christi, Sandia Quadrangle, 280323N, 975408W, 13 Jun 1992, *W.R. Carr & P. McNeal 12054* (BRIT/SMU, TEX-LL).

—William R. Carr, 1404 W. 39 1/2, Austin, TX 78756, U.S.A. and Pat McNeal, Box 371, Manchaca, TX 78652, U.S.A.

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THE BOTANY OF *SALVIA DIVINORUM* (LABIATAE)

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ABSTRACT

Salvia divinorum, ceremoniously employed by the Mazatec Indians of Oaxaca, is endemic to the sierra inhabited by the Mazatec, its distribution anthropogenic. Plants spread vegetatively, flourishing in shaded, humid sites, flowering sporadically from October until June. Flower nectar and corolla dimensions suggest ornithophily, and the only pollination event observed involved a single hummingbird, but other factors suggest that visits by birds to the flowers in their present range are opportunistic, and not a product of plant-pollinator coevolution. The species is diploid with n = 11, pollen fertility is reduced, there is no active pollen tube inhibition within the style, but some event or process after the pollen tube reaches the ovary is aberrant, as no fully developed nutlet has ever been collected from a Mexican plant, and greenhouse cross-pollinations led to only 3% seed set. Hybridity is suggested, although intermediacy between two known species has not been recognized.

RESUMEN

Salvia divinorum, que fue usada en las ceremonias por los Indios Mazatecas de Oaxaca, es una planta endémica de la sierra habitada por los Mazatecas y su distribución antropogénica. Se reproduce vegetativamente, prosperando en lugares húmedos y sombríos, y ocasionalmente florece de octubre a junio. Las dimensiones de la corola y la presencia de néctar sugieren ornitofilia y la única polinización observada fue realizada por un colibrí, pero hay otros factores que sugieren que las visitas de los pájaros a las flores son oportunistas y no el producto de una coevolución plant-polinizador. La especie es dipolide, n=11, la fertilidad del polen reducida, no hay inhibición estilar activa del tubo polínico, pero algunos procesos posteriores a la llegada del tubo polínico al ovario son aberrantes, por lo que nunca se ha recolectado ninguna nuclua perfectamente desarrollada en plantas mexicanas, y las polinizaciones cruzadas realizadas en invernadero producen sólo un 3% de semillas. Se ha sugerido hibridación, aunque no se ha reconocido que sea intermedia entre dos especies concocidas.

INTRODUCTION

Of the almost 1000 species of *Salvia* in the world, none has fired the imagination as much as *Salvia divinorum* Epling & Játiva-M, the enigmatic species ceremoniously employed by the Mazatec Indians of Oaxaca, Mexico. The western world first learned of this salvia, or sage, in 1962, when Epling and Játiva-M described the entity from specimens given to them by Albert Hofmann and Gordon Wasson (Wasson 1962; Hofmann 1980), naming it *S. divinorum* after its reported use in divination and curing by the Mazatec. Hofmann, the chemist famous for discovering LSD and isolating psilocybin and lysergic acid amides from the mushrooms and morning glories used by the Mazatecs, had explored the

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Sierra Mazateca that year with Wasson, the self-styled ethnomycologist who pioneered the investigations into the Mazatec rituals. The two criss-crossed the rugged highlands on horseback searching for *S. divinorum* in the wild, but never were able to locate it. The flowering branches that eventually reached Epling were brought to Hofmann and Wasson by Indians in the village of San Jose Tenango, though no one was willing to take them to a living plant. Wasson (1962), therefore, concluded that *S. divinorum* is a cultigen that may not exist in the wild state.

Because of the aura of secrecy surrounding *S. divinorum*, the scientific community has not known of this species until recently. A botanist making general collections is not likely to collect *S. divinorum* because its distribution is highly restricted and its flowering infrequent, thus the few existing collections of this species have all been made in conjunction with ethnological investigations.

Several aspects concerning this species beg inspection: it has been found growing only in the region inhabited by the Mazatec Indians; no plants have ever been observed to set seed in the wild; and though plants may be found flowering at any time from October until May, they apparently rarely do so. The corolla conformation suggests no clear pollination syndrome and the flowers do not point to any obvious taxonomic affinities within *Salvia*. These and other questions regarding the biological status of *S. divinorum* cannot be fully understood without consideration of the magico-divinatory aspects of the species. Although information regarding the Mazatecs is limited, recent interest in these people and their medico-religious approach to healing has shed light on certain facts that may be relevant to the natural history of the species, as the pertinent writings of Wasson and Valdés have elucidated (Wasson 1962, 1963, 1980; Wasson et al. 1974; Wasson & Wasson 1957; Valdés 1983; Valdés et al. 1983; Valdés et al. 1987).

THE MAZATEC LANDSCAPE

The Mazatec Indians have lived in a relatively isolated area in northernmost Oaxaca, wedged in between the states of Puebla and Veracruz, since well before the arrival of the Spanish in the Sixteenth Century (Fig. 1). The topography of the region is diverse, characterized by rugged highland areas virtually without level ground. The dissection of the terrain is reflected by the many dialects of the Mazatecan language spoken, and the unique "lenguage silbado," or whistle language, by which the Mazatecs can carry on a conversation with whistle sounds only. Like the yodeling of the Alpine shepherds, communication from one peak to another is made easier using a vocabulary of sounds especially tailored for that purpose. The temperate highlands of the Sierra Mazateca, roughly 1200–2500 m in elevation, grade into tropical lowlands, which comprise somewhere near 40 percent of the total area inhabited by the Mazatec (McMahon 1973; Vásquez 1981). South and east of the highland region, these areas are part of the extensive

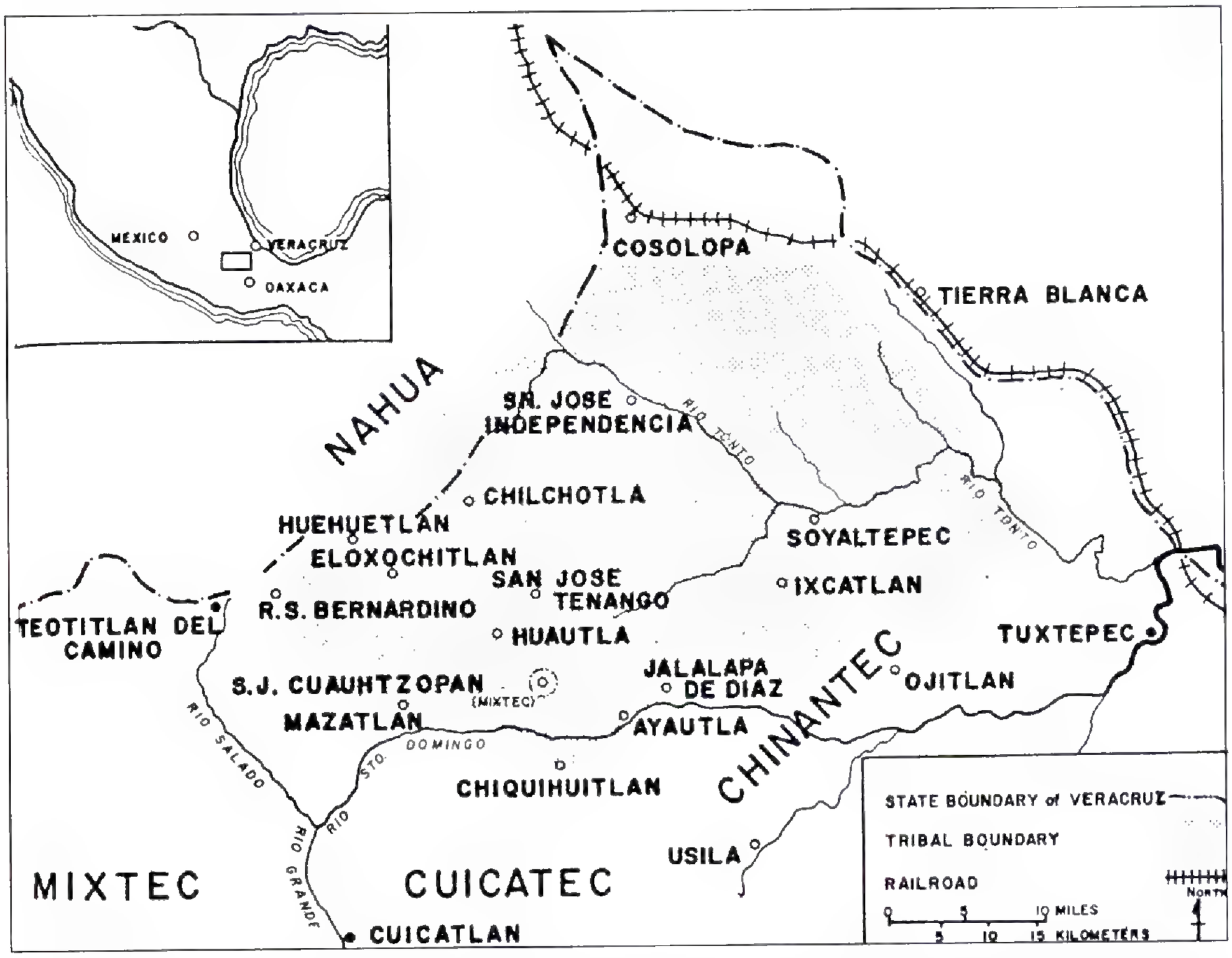

FIG. 1: Stippled region represents the area inhabited by the Mazatec. Note that the Aleman Dam, created with waters from the Tonto River, is not shown. (Map taken from Weitlaner & Hoppe 1969.)

Papaloapan river basin. About half of the roughly 1000 km^2 of lowland terrain once inhabited by the Mazatec was inundated with water in 1955 to form the Miguel Aleman Dam. This huge hydro-electric project forced over 20,000 Mazatecs to abandon their homes, and many of those displaced now live on the banks of the dam, including its eastern shores (where *S. divinorum* does not grow, see below).

The climates of highland and lowland Mazatec country are quite unlike each other. At an elevation of 1700 m, the large and central community of Huautla de Jimenez is cool and wet. Relief from the unrelenting fog comes only during the short dry season between late March and early May, though the fog is often replaced by torrential downpours in the summer. The annual precipitation ranges from 256 cm to over 400 cm in very wet years, and the average annual temperature is 61°F. To the east, at an elevation of 733 m, the village of Ayautla receives a similar amount of precipitation annually, but is warmer, with an average temperature of 68°. Still farther east is San Pedro Ixcatlan, on a peninsula surrounded by the waters of Aleman Dam, and the adjacent low-lying "tierra caliente" on the eastern side of the lake. These areas also receive a similar yearly

amount of rainfall, but they are still warmer, with annual average temperatures of over 78° (Garcia 1973; Vásquez 1981). The low-lying areas which surround the dam are much more uniform in temperature and moisture regime than the dissected highlands, and therefore are more easily characterized. The rainy seasons (June-August; September-October) and dry seasons (August, in part; March-May) are less variable than in the highlands, where different faces of a mountain may have widely different microclimates.

Previous Research

In 1963, Carl Epling placed cuttings of Hofmann and Wasson's original type collection of *S. divinorum* in the University of California, Los Angeles (UCLA) Botanical Gardens. Epling never saw these plants flower in the gardens at UCLA, and mistakenly described them as having blue corollas. The source of this error is made apparent by Hofmann (1980), who recalls the time he and Wasson received the plant material:

> "From an old Curandera, a venerable woman in a strikingly magnificent Mazatec garment, with the lovely name Natividad Rosa, we received a whole bundle of flowering specimens of the sought-after plant,...[she would not] tell us where she had gathered the leaves. They grew in a very, very distant forest valley. Wherever she dug up the plant, she put a coffee bean in the earth as thanks to the gods....We now possessed ample plants with flowers and roots, which were suitable for botanical identification....The plants had blue flowers crowned with a white dome..."

In fact, the white dome referred to by Hofmann was the corolla, which, in the specimen described, had apparently not yet opened. Likewise, the illustration of *S. divinorum* in Schultes and Hofmann (1980) includes only flowers in bud, and the artist's rendition of the individual flower parts emphasizes the mistake: the stamen, style, and corolla are each drawn as they appear before the flower opens. Hofmann and Wasson, neither of whom had any idea what the flowers of this *Salvia* look like, did not realize what they described as "blue flowers, crowned with a white dome" were actually blue calyces with unopened white corollas. The mistake survived in Epling and Játiva's (1962) original description of the species because they never themselves saw living flowers, and the white corollas turn brown upon drying. Díaz (1975), Emboden (1979), Valdés (1983), and Valdés et al. (1987) have all correctly reported that the corollas of *S. divinorum* are pure white, while the calyx and flowering stem are violet blue.

In the course of his pharmacological research, L.J. Valdés (1983) and Valdés et al. (1987) performed several experiments designed to help answer questions regarding the reproductive biology of *S. divinorum*. Of the 14 flowers he cross-pollinated by hand, four set seed, though the number of nutlets that reached maturity is unclear (the ovary of each flower consists of four mericarps). Valdés

concluded that the species is self-sterile, though apparently no attempt was made to self-pollinate any flowers. Daylength experiments, carried out in order to explain the blooming requirements of *S. divinorum*, suggested that it is an obligate short-day plant, with plant height a minor factor in flower initiation. Still, the sporadic flowering of wild populations, the conditions that promote flower initiation, and the failure of the flowers to lead to fruit formation are aspects which remained unclear. These and other questions regarding coevolved pollinators and biological status are addressed below. Investigations of the author (Reisfield 1987) described here have involved visiting and collecting material from many populations in the field, a "stakeout" at a flowering population to observe pollinators, chromosome number determination, greenhouse flower induction experiments, artificial self- and cross-pollinations, pollen stainability studies, fluorescence microscopy of pollen tube growth through styles, and nectar analyses.

MATERIALS AND METHODS

Fieldwork carried out during the winter of 1983-84 consisted mainly of searching the Sierra Mazateca for populations of *S. divinorum*. Flowering populations near Cerro Quemado, a village on the western side of the Aleman Dam, were visited in October, 1985, and watched for two days and one night in order to note any visitors to the flowers. Plants were observed during the night by periodical inspection using a red-filtered incandescent lamp. After being visited, flowers were inspected to see whether pollen had been deposited on the stigma, and whether the store of nectar had been depleted.

Plants of *S. divinorum* from several sources were propagated at the University of Wisconsin-Madison Botany Department (UW) Greenhouses. Valdés generously provided potted plants derived from three sources: a collection from Cerro Rabon, near the Mazatec village of Ayautla, a collection from near the village of Cerro Quemado, and clonotypic material obtained from Berkeley. Later, plants I collected near Cerro Quemado (*Reisfield & Solheim 1102*) and Ayautla (*Reisfield & Solheim 1111*) were added to the living collections.

Valdés learned from Robert Ornduff (pers. com.) that plants grown in the gardens at both UC Berkeley and UCLA formed flower buds that subsequently reverted to vegetative growth. (This, in fact, also occurred on plants growing in the UW greenhouses during the winter of 1986-87). Apparently, a limited exposure to light during the night will upset the hormonal mechanism by which the plant perceives a decrease in daylength. Thus, beginning in late October, 1984, a subset of plants at the UW greenhouses were subjected to artificially shortened days of 8-10 hours by covering them with a black cloth each afternoon.

Flowers were hand-pollinated by removing the stamens and immediately

brushing the dehiscing anthers against the inner surfaces of both stigma branches until pollen grains adhered to the stigma. Self-pollinations were performed within individual flowers, between flowers of the same plant, and between plants derived from a common source, while cross-pollinations were performed between plants derived from different sources. Pollinations were performed at different times during the day (and night), and between flowers of different ages.

To study pollen germination and pollen tube growth, styles were collected from flowers that had been self- or cross-pollinated between 4 and 18 hrs earlier. The styles were fixed in FAA and stored in distilled water at approximately 5°C. They were cleared with 8N sodium hydroxide for 24 hrs, then taken through several washes with distilled water, and stained with aniline blue at a concentration of .01 percent for 4 hrs. Fluorescence microscopy was performed with a Zeiss microscope equipped with a Zeiss UG1 excitation filter and 47,-65 barrier filters. The UV source was an Osram HBO 200W mercury vapor lamp. Staining and microscopy techniques mostly followed Martin (1959) as modified by Stettler and Guries (1976). Styles were slightly crushed beneath a coverslip and observed whole in a darkened room. The callosic lining of the pollen tubes fluoresces a bright yellow-green, but the amount and distribution of callose varies between taxa (Martin 1959). Scanning several unrelated species of *Salvia* showed that pollen tubes come in and out of visibility over the length of the style, and can easily be distinguished from the two vascular bundles which fluoresce a uniform, much less brilliant yellow. Since fluorescence was most visible at the stigmatic and ovary ends of the style, an inability of the tubes to reach the ovary should have been readily detectable.

Pollen grains from FAA-preserved flowers on wild and greenhouse-grown plants were analyzed for cytoplasm stainability. Sterile or aborted pollen grains did not take up the cotton blue-lactophenol stain, and were also conspicuous by their shrunken size and shriveled form.

Nectar studies included an analysis of constituents, a study of daily secretion patterns, and also total volumes produced per flower. Calibrated micropipettes were inserted into the pool of nectar that accumulates at the base of the corolla tube, with nectar extracted by capillary action. Sugar concentrations were measured with an Extech model 2132 pocket refractometer, with several nectar samples also analyzed for sugar constituents (ratio) by Irene Baker at UC Berkeley. The nectar was spotted on Whatman #2 filter paper, the diameter of the spot outlined with four pencil marks, and the volume and percent sugar for each spot provided to Dr. Baker.

Young anther sacs were dissected and meiocytes squashed according to the technique of Beeks (1955). These were viewed with a Zeiss phase-contrast microscope.

RESULTS AND DISCUSSION

Distribution, Ecology, and Flower Initiation

During the winter of 1984-85, approximately 15 populations of *S. divinorum* were located, though for the purpose of mapping their distribution, several populations are merged because of their proximity (Fig. 2). *Salvia divinorum* was first located (*Reisfield & Solheim 1077*) about 2 km north of the village of Huautla de Jimenez in a very wet, somewhat disturbed, shaded ravine at the edge of a coffee plantation. The coffee plantation apparently replaced a cloud forest, the remnants of which included *Liquidambar macrophylla* Oerst. and *Hedyosmum mexicanum* Cordem. Plants of *S. divinorum* were found growing along a stream bank, with some stems trailing near or in water, rooting copiously at the nodes and sometimes along internodes. Broken, trailing, and drooping stems were noticed to resume erect growth at the stem apex or by axillary branching, with new, vigorous shoots often arising from the axils of old, senescent stems. All living stems were observed to arise from stems that had since died, the dead stems lying on or in the ground, sometimes appearing as woody caudices. Many stems were cut, apparently by people who collected the leaves for medico-religious use. Several old, dried, inflorescence branches (rachises) were present but no fruit were found. Later, similar populations (*Reisfield & Solheim 1090, 1092*) were found in other ravines near Huautla.

The road from Huautla (1700 m) to Ayautla (760 m) is copiously criss-crossed by streams and wet ravines that were searched for populations of *S. divinorum*. A few such populations (*Reisfield & Solheim 1111-12*) were finally found near Ayautla, and these again showed signs of past flowering, but all the old floral stems were entirely naked (in *Salvia*, the developing fruit are enclosed by a persistent calyx, but failure of the nutlets to develop normally leads to calyx abscission). The plants were spreading vigorously along the rocky stream banks, and erect shoots emerged mostly from a thick litter composed of older decaying stems. One branch was completely severed, lying in shallow water and rooting along the internodes. An additional population in this area, chosen by a local shaman, Maria de la Oz Unda, to supply the leaves for the divinatory ceremony we had requested, grew among the trees of a coffee plantation. Although there was no running water at this site, the many epiphytic ferns and orchids suggested that this wooded mountain slope is regularly blanketed in fog. Similar stands of *S. divinorum* in "cafetals" were found near Huautla (*Reisfield & Solheim 1090*) and Cerro Quemado (*Reisfield & Solheim 1108*).

Flowering of *S. divinorum*, as in many forest understory species, is promoted by sunlight, and the extent of flowering of a given population is dictated by the amount of sunlight that penetrates the canopy. We saw our first flowering population of *S. divinorum* (*Reisfield & Solheim 1093*) near the village of Chilchotla

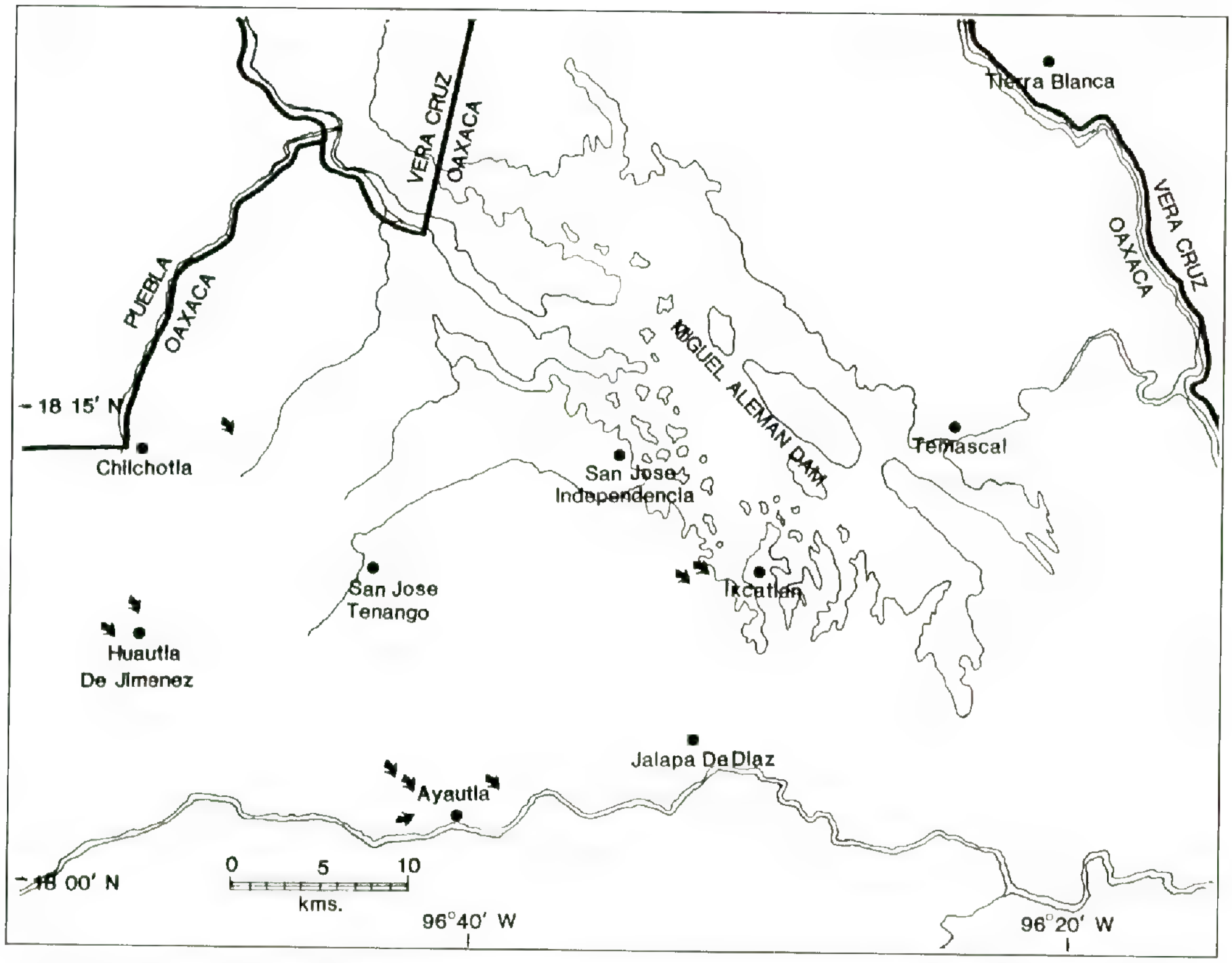

FIG. 2: Distribution of *Salvia divinorum* Epl. & Jat. Arrows point to populations found during fieldwork in the winter of 1984–85. In addition to the locations shown, the type specimen was collected in (near?) San Jose Tenango. Miguel Aleman Dam refers to the lake. (Adapted from McMahon 1973.)

(1200 m). The plants colonized the banks of a broad, shaded ravine with several pools of standing water. The channel of the ravine was mostly without vegetation and almost certainly flooded during wetter periods. The vegetation suggested a transition between cloud forest (e.g., *Hedyosmum*, *Liquidambar*) and tropical evergreen forest (e.g., *Syngonium* and other Araceae), and climatic data (Garcia 1973) indicates that this area is extremely humid, with an annual average of 472 cm of rain. This flourishing population of plants appeared to be clonal, spreading vegetatively in the same fashion as populations observed previously. Inflorescence rachises past the flowering stage were again entirely naked, and not a single mature nutlet was found. The beautiful white and violet flowering stems, found only in patches where sunlight penetrated the canopy, were very conspicuous. This observation suggests the main distinction between this and previous sites where populations of *S. divinorum* were found. The breadth of this ravine allows a greater penetration of sunlight, while the extreme humidity of the region prevents even sunny microhabitats from drying out. It is this interplay between sunlight and humidity that apparently dictates the success and the extent of flowering of a given local population of *S. divinorum*.

Another flowering population (*Reisfield & Solheim 1109*) was found on a steep face of Cerro Alto, the mountain adjacent to the village of Ayautla. This trailside population formed a thick, shaded stand, with crowded stems over 2 m tall. Flowering branches, up to 3 m tall, rose above the rest and received filtered or direct sunlight. Valdés (1983) reported he collected plants from Cerro Rabon, a somewhat more distant mountain, but our local guide, Pedro Díaz, insisted that he knows "La Maria [*S. divinorum*] very well, and in 40 years of walking Cerro Rabon, [he] never saw it up there."

Several populations of *S. divinorum* (*Reisfield & Solheim 1102-03, 1106-08*) were found on the east-facing bluffs above the village of Cerro Quemado, on the western bank of the Aleman Dam. At roughly 300-400 m elevation, these stands were scattered along a steep trail that winds between the peaks of Cerro Quemado and Cerro Camaron. Some plants were found in a slash-and-burn cornfield, where most of the associated vegetation was disturbed, replacing a tropical evergreen forest with *Brosimum*, *Dendropanax*, and *Urera*. Many flowering stems were found, these always in partial to full sunlight, sometimes dried out to the degree that the leaves were badly wilted. Climatic data for the nearby village of Ixcatlan (Garcia 1973) indicates that this area is considerably warmer than the highland regions of the Sierra Mazateca, the wilting plants perhaps demonstrating that *S. divinorum* is here at its limit of evapo-transpiration tolerance. On the other hand, these same populations included more flowering stems than any other, again indicating that flowering of *S. divinorum* is promoted by sunlight, and perhaps the stress of drying out to a certain degree. This is reasonable in light of the heliotrophic nature of *Salvia* in general, with mostly species of open ground and with brightly colored flowers. *Salvia divinorum*, though, with its crisp, watery, easily broken, hollow stems, is clearly a hydrophyte, and most aggressively colonizes sites that are dark and humid. Vigorous, flowering populations are found in conditions of marginal light, and in very humid areas (e.g., Chilchotla), the plants can "venture out of the shade" into the sunlight where they will flower.

Conditions that promote vegetative growth of *S. divinorum* are different than those that promote flowering, and this is reflected in the character and distribution of populations. The Mazatecs displaced by the Aleman Dam, who now live in the low-lying "tierra caliente" on the eastern side of the dam, have tried, unsuccessfully, to cultivate *S. divinorum* (Díaz, pers. com.). This region receives similar amounts of rainfall as the highland areas of the Sierra Mazateca, but is warmer, and consequently drier. Thus, in order to gather fresh leaves, some of these Indians travel by boat across the lake to the hillsides near Cerro Quemado, where the populations are at their limit of evapo-transpiration. Throughout the higher, cooler regions inhabited by the Mazatec, flourishing populations may be found in shaded ravines near water, or on mountainsides continuously bathed in fog. In the latter type of site, often a hillside planted to coffee, *S. divinorum* is almost certainly introduced, and the Mazatecs do this by simply sticking a severed

branch into the soil. Though the more remote, aggressive populations along watercourses seem not to have been planted, they may in fact have been introduced long ago. The Mazatecs do not distinguish between wild and cultivated populations, nor do they attach any significance to the flowers.

While Emboden (1979) reported that *S. divinorum* flowers only when the "branches" [stems] are seven feet or more in length, Valdés et al. (1987) concluded that plant height is a minor factor in flower initiation. In the Sierra Mazateca, most flowering stems are, in fact, very long, since the stems that elongate the most are most likely to receive direct sunlight. Plants grown in the University of Wisconsin Greenhouses received unfiltered sunlight, and those which were subjected to the short-day treatment flowered profusely on branches of varying lengths.

Flower buds on greenhouse-grown plants were first noted roughly 2 months after the beginning of the short day treatment, and the first flowers did not open until almost one month later. The nearly 3 month lag between the time the plants first perceived the stimulus to flower and the onset of flowering correlates with the results of Valdés et al. (1987), but raises the question of whether any critical threshold period is really perceived by the plants. The type specimen was collected in flower by Hofmann and Wasson on October 8 (I am unaware of the collection flowering in August, referred to by Valdés), which suggests that these plants perceived the stimulus to flower more than 3 months earlier, that is, in late June, during the period with the longest days of the year. The mechanism responsible for flower induction is apparently not as simple as our greenhouse and growth chamber experiments would suggest, and the actual induction of flower primordia probably involves several factors, including temperature and water regimes. Perhaps the critical stimulus perceived by the plant is an increase in the length of the night *per se*, an hypothesis that could easily be tested. Flowering plants have been collected from near Cerro Quemado in March, and local villagers insisted *S. divinorum* flowers most abundantly in March, April, and May, when it is the driest. In light of the conditions that promote flowering during the cool and wet winter, these assertions seem more than reasonable.

Co-Evolved Pollinators

Although several flowering populations were finally found during the winter of 1983-84, at no time was a legitimate pollinator observed visiting flowers. While poor flight conditions for Hymenoptera often prevailed, pollinators were also conspicuously absent during an entire, sunny, hot afternoon while flowers were collected near Cerro Quemado. Bumblebees were active in the area, but they ignored the white and violet inflorescences of *S. divinorum* as they do scarlet flowers of many ornithophilous *Salvia*. The explanation for this behavior is suggested by the dimensions of the *S. divinorum* corolla, which more resembles those of ornithophilous salvias than melittophilous ones (Fig. 3). The sigmoid corolla

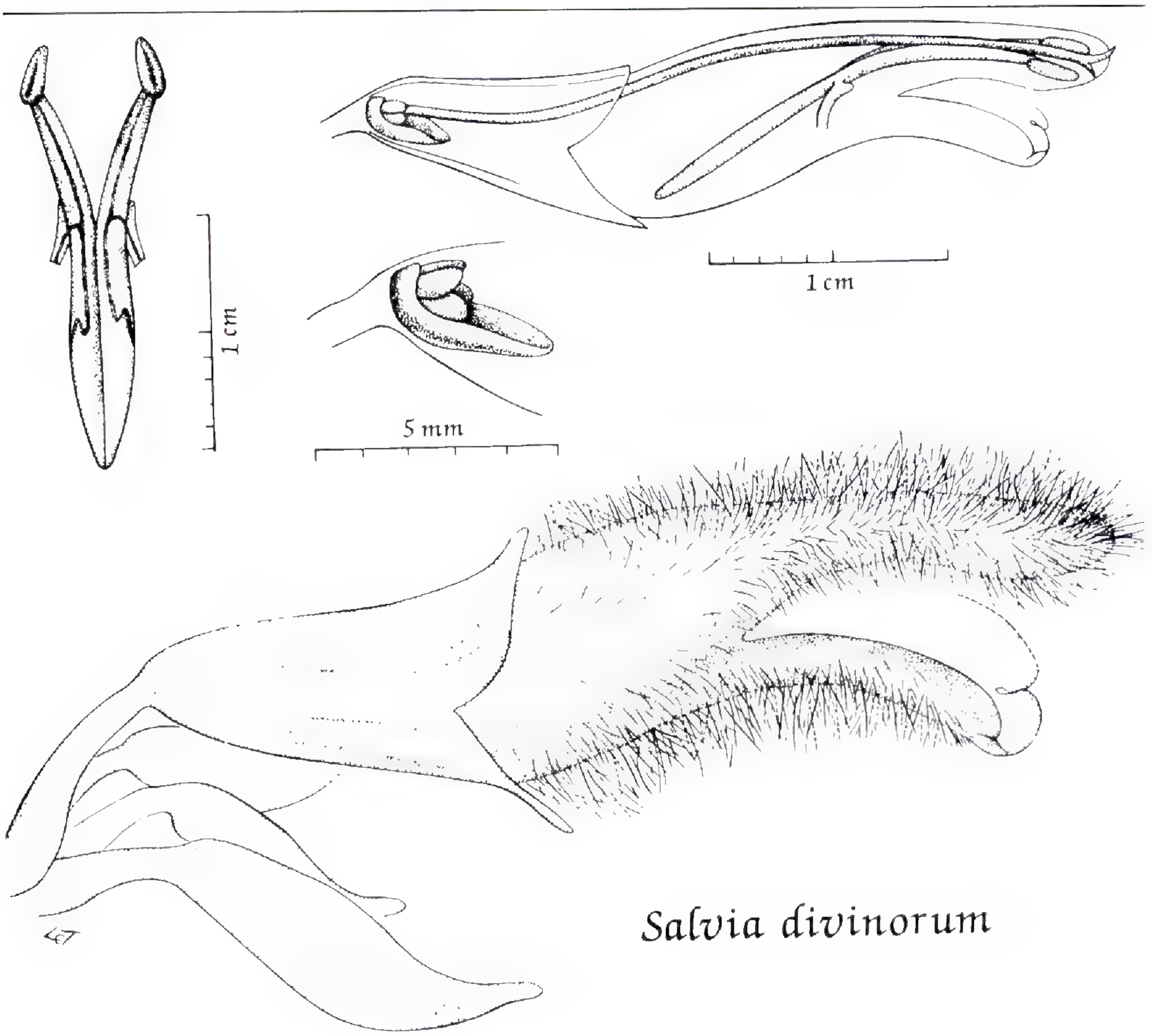

Fig. 3: a. Flower of *Salvia divinorum*; b. Diagrammatic illustration of flower with contained androecium and pistil; c. Stamen connectives; d. Ovary and gynobase. (Illustration by Lucy Taylor.)

tube is 19–22 mm long, and measures only 2 by 1.5 mm at its narrowest point, near the throat. The lower lip, which is horizontally expanded to form a landing platform on bee flowers, is instead vertically oriented, with the middle lobe somewhat cupped, like those of classical hummingbird pollinated salvias. The sigmoid curvature of the corolla tube is uncommon in bee flowers, but characterizes several bird pollinated species of *Salvia*, such as those in sect. *Flexuosae* Epling.

Data obtained from analyzing nectar constituents are consistent with ornithophily. As might be expected, the nectar sugar is sucrose dominant, as are most nectars from flowers pollinated by long-tongued bees, hawkmoths, or birds. Flowers from clonotypic plants yielded a nectar sugar composed of 86% sucrose, 10% fructose, and 4% glucose. This evidence is even less meaningful in light of the fact that the Labiatae, as a group, are characterized by sucrose-rich or sucrose-dominant nectar sugars (Baker & Baker 1983).

While the corolla tube of *S. divinorum* suggests a co-evolved pollinator with

long mouthparts, information concerning nectar sugar concentration and the volume of nectar secreted can help resolve further the identity of this long-tongued pollinator. Nectars sampled by Cruden et al. (1981) from a spectrum of Mexican plants below 2400 m showed that bee flowers produce more concentrated nectars (34.7%) than hawkmoth- (22.6%) and bird-pollinated (23.8%) flowers. The concentration of nectar sugar produced by greenhouse-grown plants of *S. divinorum* was mostly between 21% and 23%. In general, hummingbird flowers have low nectar-sugar concentrations, but produce larger total quantities of nectar than bee flowers. Because of the interplay between pollinator adaptation, on the one hand, and the constraints of phylogenetic relationship, on the other (Baker & Baker 1983), data presented by Cruden et al. (1981) from several species of *Salvia* are especially useful for comparison with data obtained from *S. divinorum*. Ornithophilous species of *Salvia* sampled by Cruden et al. included *S. cardinalis* (17.71 µl per flower), *S. elegans* (7.52 µl), *S. greggi* (3.49 µl), and *S. pubescens* (20.72 µl). Melittophilous species sampled included *S. tiliaefolia* (0.015 µl per flower), *S. reflexa* (0.14 µl), and *S. cohuilensis* (0.53 µl). Despite the fact that nectar accumulation data obtained by intermittently sampling flowers of *S. divinorum* grown in the greenhouse are plagued with inconsistencies, there is no question that the quantity of nectar produced suggests ornithophily, with measurements ranging from 8–16 µl, most flowers producing a total quantity of nectar near 9 µl. Still, several questions emerged, such as the possible negative effect of the intrusive sampling technique, the effect of nectar removal on secretion rates, and the effect of the time of secretion on the quantity of nectar produced, since flowering and nectar production were asynchronous.

No nocturnal visitors were observed during the overnight stakeout near flowering populations of *S. divinorum* at Cerro Quemado. Flowers opened asynchronously in the evening or during the night, and nectar production was also initiated asynchronously, mostly during the night. Virtually three of every four flowers had a hole punctured in the calyx and corolla tube, presumably by nectar robbers, and even many unopened flowers containing little or no nectar were pierced. At the first signs of dawn, under an overcast sky, a single, large hummingbird with a conspicuously decurved bill visited virtually every flower, flitting from flower to flower in an irregular fashion. It flew away in the direction of additional flowering stands of *S. divinorum*, and several minutes later returned and again visited most flowers. The nectar in most of the flowers was depleted by the bird, and pollen grains had been deposited on several stigmas. Two bumblebees were in the area but ignored the *Salvia* flowers.

The observations described can in no way be considered evidence for the co-evolution between *S. divinorum* and a species of hummingbird, especially in light of the many supposed melittophilous salvias that are visited by these opportunistic birds (Reisfield 1987). Still, dimensions of the corolla, nectar constituents, and the amount of nectar produced per flower, all suggest the ornithophilous

syndrome. On the other hand, anthropogenic distribution, white corolla color, sporadic and infrequent flowering of populations during most of the year, the great amount of nectar robbing, and apparent complete lack of fruit set, suggest the relationship between plant and pollinator has not been "fine-tuned" by natural selection.

The Barrier To Fertility

Meiocytes from anthers of *S. divinorum* (*Reisfield 1242*) flower buds were suitable for chromosome counting during the first and second metaphase. No irregularities in pairing were observed, and the species was found to be diploid, with n=11 (photograph of squash in Reisfield 1987), which is the number most common in species of subg. *Calosphace*. Nevertheless, many examples of species are known in which chromosome pairing appears normal, but meiosis breaks down in the later stages and pollen grains fail to develop, due to various types and degrees of chromosome non-homology or genic sterility (Stebbins 1958). A failure during the late stages of meiosis or during gametogenesis would normally lead to unviable pollen grains, often reflecting a disharmonious interaction of parental genes, usually indicating hybridity. A scan of pollen from preserved flowers of *Salvia sessei* Benth. (*Reisfield 1252*), *S. flaccidifolia* Fern. (*Reisfield 1218*), and *S. mexicana* L. (*Reisfield 1244*), revealed that virtually all the pollen grains took up the stain. Pollen grains of *S. divinorum* from greenhouse-grown plants (mixed collections) were much less viable, with 882 (56%) of the 1587 pollen grains observed aborted. Pollen from flowers of *S. divinorum* collected at Cerro Quemado (*Reisfield 1242*) showed a similarly low degree of fertility relative to other *Salvia* species, with 1592 (53%) aborted pollen grains out of 3027 observed. Haplontic and/or diplontic sterility of interspecific hybrids is often similarly manifested, indicating the taxon may be of hybrid origin. Still, the inviability of the haploid stage in the life cycle is only partial, and can not explain why the plants apparently set no seed in Mexico.

Hand pollinations in the greenhouse clearly showed the chief barrier to fertility in *S. divinorum* is not a failure to be pollinated. Of a total of 108 self-pollinations (108 stigmas dusted with pollen from the same plant or genetically identical plants), only 11 mericarps developed fully into dark, indurate, viable nutlets. Since each pollinated flower could potentially yield four nutlets, the 11 fruit represent 2.5% of a total potential yield of 432 fruit. Of 190 cross-pollinations, only 24 (3%) nutlets fully matured from a potential of 760 fruit. Most of the calyces abscised between 5 and 10 days after pollination, and quite often one or two (sometimes more) mericarps were noticed to be developing before the calyx and ovary fell from the plant. Several of the mature seeds were germinated in the UW Greenhouses, and vigorous seedlings developed into plants indistinguishable (though not grown to flowering) from their parents. Since flowering is so sporadic in Mexico, pollination may, in fact, be undependable. Furthermore,

pollen seems not to adhere to the stigma with great efficiency. Still, many viable pollen grains that were deposited on receptive stigmas did not lead to fruit set, indicating some failure after this stage in the life cycle of *S. divinorum*.

It has been suggested that *S. divinorum* is self-sterile (Valdés 1983; Valdés et al. 1987) which, if true, would explain the observed failure to set fruit. Individual populations all seem to be clonal, and plants of adjacent populations could feasibly be genetically identical. Given the anthropogenic distribution of *S. divinorum* throughout the region inhabited by the Mazatec, it is also quite possible that many distinct populations are derived from a single source. Such a situation would explain why artificial cross-pollinations resulted in no greater fruit set than self-pollinations, since the so called cross-pollinations would, in reality, be between genetically identical plants. Even if plants were not genetically identical, a common self-incompatibility factor shared by the functional male and female plants would prevent successful fertilization. This type of self rejection, though, seems to be rare in *Salvia* (few studies have been done), and also could not account for the reduction in pollen fertility.

Further resolution of the problem was obtained by studying pollen germination and tube growth through styles of hand-pollinated flowers. Of 39 styles observed, 13 (33%) had four or more pollen tubes that traversed the entire length of the style, reaching the ovary. Three or more pollen tubes reached the ovary in almost one half the styles observed. Of the 20 styles in which four or more pollen grains or tubes were observable at all, 14 had three or more pollen tubes that reached the ovary. Also, no difference was noted between the self- and supposed cross-pollinations.

In classical genetic self-incompatibility systems, the site of pollen tube inhibition is on the stigma surface or somewhere in the style. A pollen grain may fail to germinate, or produces a tube that grows abnormally and is soon occluded by callose, or produces a tube that is eventually rejected by the transmitting tissue of the style (Heslop-Harrison 1975). Although this type of active inhibition of the pollen tube may not be the only form of genetic mate discrimination in plants (Mulcahy & Mulcahy 1983), the best understood self-rejection systems (oppositional systems) do involve observable changes (e.g., swelling) in the growing tip of the pollen tube. No such abnormalities were observed for *S. divinorum*, and no occlusions were found anywhere in the style. A barrier to seed set is apparently encountered after pollen tubes reach the ovary, at some point between the time the tube enters the micropyle of the ovule and the early development of the embryo. Since calyces often abscise while the included nutlets are developing, post-zygotic embryo abortion or endosperm failure is probable. Whether this is due to inbreeding depression, hybridity, or a late acting (delayed) self-incompatibility reaction is difficult to know with certainty. The latter is unlikely, especially because gametogenesis and other stages of the life cycle are also irregular, and one would think the various aberrations have a common cause. Inbreeding depression

is often the fate of taxa that become closely associated with man, and could potentially cause the observed irregularities.

The various anomalies that characterize *Salvia divinorum* might perhaps be best explained as due to hybridity, but unfortunately, additional evidence is lacking. To none of the almost 500 species that comprise the Neotropical *Salvia* subg. *Calosphace* (Benth.) Benth. does *S. divinorum* show any obvious affinity, nor is intermediacy between two known species evident. Although the various character states of *S. divinorum* are encountered at one place or another within subg. *Calosphace*, I have been unable to identify the two species, out of the hundreds, which, when crossed, might have produced offspring that look like *S. divinorum*. The species is certainly anomalous in sect. *Dusenostachys* Epl. (Epling 1939), to which it was originally assigned (Epling & Játiva 1962).

The Mazatecs say that "La Maria [*S. divinorum*] speaks with a quiet voice," which may explain, in part, why many issues concerning this enigmatic plant remain unsolved. Whether of hybrid origin or an inbred cultigen, questions regarding taxonomic affinities, fruit abortion, native distribution, and pharmacology are yet to be conclusively resolved.

AMENDED DESCRIPTION OF *SALVIA DIVINORUM* EPLING & JÁTIVA-M.

Salvia divinorum Epling & Játiva, Bot. Mus. Leafl. 20: 75-76. 1962. TYPE: MEXICO. EDO. OAXACA: San José Tenango, 8 Oct 1962, *Albert Hofmann & R. Gordon Wasson s.n.* (HOLOTYPE: LA; ISOTYPES: LA in UC, ECON).

Perennial herb, mostly 0.5–1.5 m tall vegetatively, flowering stems 1–2(–3) m tall, taller stems decumbent for part of their length; stems often trailing along rocky stream banks, sometimes in running water, rooting copiously at the nodes and sometimes along internodes, with broken, trailing, and drooping stems resuming erect growth at stem apices or by axillary branching, the new, vigorous shoots often arising from axils of old, senescent stems, these decaying or dead stems often appearing as woody caudices. *Stems* quadrangular, with flanged angles, hollow, fleshy and crisp, translucent, breaking easily, hirtellous, green. *Leaves* opposite, elliptic to ovate, acuminate to caudate at the apex, attenuate at the base, petioles scarcely differentiated from the blade, 10–25(–30) cm long, 5–10 cm wide, glabrous above, sparingly glandular-punctate below; margins irregularly serrate or crenate-serrate, to entire at the base. *Racemes* simple, erect, 30–40 cm long, with 2–4 cm long internodes; cymules with 3–6(–12) flowers each; rachis hirsute, glabrate. *Bracts* sessile, concave, ovate, rounded at the base, acuminate-caudate at the apex, 1–2(–3) cm long, 0.6–1 cm wide, mostly violet, tardily deciduous. *Pedicels* straight, slender, hirsute, violet, 4–9 mm long. *Calyx* gradually widened above, 10–12 mm long, with subequal lips, glandular-hispid along the veins in bud, glabrate to glandular-puberulent throughout, violet; upper lip 1.5 mm long, with 3 major veins. *Corolla* sigmoid, 28–32 mm long, densely villous with multicellular translucent hairs 0.5–2 mm long especially on

upper and lower lips, glabrous within, white, drying brown in herbarium material, lips becoming tinged blue with age; tube 19–22 mm long, 2 mm high by 1.5 mm wide at the narrowest point near the throat; galea (upper lip) 8–9(10) mm long; lower lip cupped, 5 mm long, 7 mm wide when flattened out, middle lobe emarginate. *Stamens* included within the galea, inserted near the throat, glabrous, white; connectives somewhat rigid, slightly arcuate, 15–16 mm long, 17–18 mm long when flattened out, rudders 10–11 mm long, entire; anthers 2 mm long; pollen white. *Style* 27–32 mm long, densely bearded below the stigma, white; posterior (upper) stigma branch exserted beyond the galea and curling upward, 2 mm long, 2.5 mm long when flattened out; anterior branch sometimes slightly exserted from the galea, somewhat carinate, 1.5 mm long. *Gynobase* horn 3 mm long, 1.2 mm wide, glabrous, white. *Nutlets* when mature 1.8–2 mm long, 1(1.2) mm wide, somewhat pyriform, minutely tuberculate, dark brown, to date never collected in the wild. *Endemic* to the Sierra Mazateca, Oaxaca, Mexico, at elev. of 300–1800 m, in primary and secondary cloud forest and tropical evergreen forest, with many populations cultivated or semi-cultivated (weedy), often spreading vegetatively along streambanks, flowering sporadically from September to May.

Specimens examined: MEXICO. **Edo. Oaxaca**. Sierra Mazateca: 2 km NNW of Huautla market, 6 Jan 1984, *Reisfield & Solheim 1077* (WIS); 1 km SW of Huautla market, 15 Jan 1984, *Reisfield & Solheim 1090* (WIS); ca. 2 km SW of Huautla market, 15 Jan 1984, *Reisfield & Solheim 1092* (WIS); Huautla, 1960, *Wasson s.n.* (ECON); Huautla, 24 Nov 1962, *Bunnell s.n.* (LA in UC); Huautla, Sep 1957, *Gomez-Pompa 500-E* (GH); Cuauhtemoc, ca. 4 km NE of Santa Maria Chilchotla, 16 Jan 1984, *Reisfield & Solheim 1093* (WIS); La Soledad, ca. 3.5 km WNW of Ayautla, 13 Feb 1984, *Reisfield & Solheim 1111* (WIS); 2.5 km W of Ayautla on road to San Juan, 13 Feb 1984, *Reisfield & Solheim 1112* (WIS); Cerro Alto, ca. 2 km NE of Ayautla, 13 Feb 1984, *Reisfield & Solheim 1109* (WIS); Cerro Camaron, 0.5 km W of Cerro Quemado Centro, 8 Feb 1984, *Reisfield & Solheim 1102* (WIS); ca. 0.75 km W of Cerro Quemado, 9 Feb 1984, *Reisfield & Solheim 1103* (WIS); 1 km W of Cerro Quemado, 9 Feb 1984, *Reisfield & Solheim 1106* (WIS); 1.5 km W of Cerro Quemado, 9 Feb 1984, *Reisfield & Solheim 1107* (WIS); ca. 1 km NNW of Cerro Quemado centro, 10 Feb 1984, *Reisfield & Solheim 1108* (WIS); 1 km W of Cerro Quemado, 27 Oct 1985, *Reisfield 1242* (WIS); Cerro Quemado, 2 Mar 1980, *Valdés & Paul s.n.* (MICH).

UNITED STATES. **California**. California State University, Hayward, cultivated from material of uncertain origin, 24 Jan 1980, *Wilcox s.n.* (ECON). Northridge, cultivated at San Fernando Valley State College from material of uncertain origin, *Emboden s.n.* (ECON). **Michigan**. University of Michigan Botanical Gardens, cultivated from material obtained at Cerro Quemado, 20 Apr 1980, 17 Nov 1980, *Valdés s.n.* (MICH).

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STAUROGYNE AGRESTIS (ACANTHACEAE), A GENUS AND SPECIES NEW TO MEXICO

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ABSTRACT

On the basis of historical and recent collections, *Staurogyne agrestis* is reported from western Mexico. This is the first report of this genus in North America. Descriptions and illustrations are provided of this poorly known species. *Staurogyne* is compared with other Mexican Nelsonioideae.

RESUMEN

Se cita por primera vez para México (y América del Norte) *Staurogyne agrestis*. Se describe e ilustra esta especie poco conocida. También se ofrece una clave de todos los géneros de la subfamilia Nelsonioideae en México.

Staurogyne Wallich comprises between 80 (Bremekamp 1955) and 140 (Champluvier 1991) species occurring in tropical America, Africa, and Asia (with one species extending into Australia). There are two major centers of diversity for species of the genus: Indo-Malesia and Brazil. Taxonomically, the genus has traditionally been treated in the subfamily Nelsonioideae of the Acanthaceae (Lindau 1895). Several students of the family (e.g., Bremekamp 1965, Sreemadhavan 1977) have advocated excluding the Nelsonioideae from the Acanthaceae. Bremekamp (1953) removed the subfamily to the Scrophulariaceae as tribe Nelsonieae. Sreemadhavan (1977) elevated Lindau's Nelsonioideae to familial status. There is no general agreement on taxonomic placement of the genera comprising the Nelsonioideae; however, most recent floristic accounts have adopted a traditional approach and included the subfamily in the Acanthaceae. Improved taxonomic resolution awaits monographic and perhaps molecular studies of these genera.

The Mexican genera of Lindau's Nelsonioideae can be distinguished by the following key:

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1. Leaves alternate or clustered in pseudowhorls; spikes borne on long scaly peduncles, the scales alternate; stigma undivided, wider than 5 times the width of the style, folded over and enclosing anthers in undisturbed flowers, unfolding and becoming erect when touched. ..... *Elytraria*
1. Leaves opposite; spikes sessile or borne on naked peduncles; stigma divided into 2 or more segments, these ≤ the width of the style, neither folded nor enclosing anthers, not touch-sensitive.
   2. Stamens 4; anterior lobes of calyx fused for only a short distance above base. ..... *Staurogyne*
   2. Stamens 2; anterior lobes of calyx fused for more than half their length ..... *Nelsonia*

Recent comprehensive studies of the genus include Bremekamp's (1955) revision of the Malaysian species and Champluvier's (1991) treatment of the five species in tropical Africa.

Most American species of *Staurogyne* have been described from Brazil (Leonard 1951). Only *Staurogyne agrestis* has been reported from Central America and it is known from few collections. The Mexican collections of *Staurogyne* noted below are the first to be reported from North America.

Staurogyne Wallich, Pl. Asiat. Rar. 2:80. 1831.

Herbs, sometimes suffrutescent, rarely acaulescent; stems prostrate to decumbent or ascendant to erect. Leaves opposite (or distal ones sometimes subopposite or alternate), petiolate; blades entire or shallowly dentate. Inflorescence of axillary and/or terminal spikes or racemes, these sometimes forming panicles. Calyx deeply 5-lobed, lobes equal, subequal, or usually unequal with the posterior lobe larger than others. Corolla white to yellow (sometimes with pink or purplish markings; rarely entirely red, pink, or purple), limb subregular or bilabiate, if bilabiate then upper lip 2-lobed and lower lip 3-lobed. Stamens 4 (rarely 2), didynamous, included or slightly exserted, anthers bithecous, thecae parallel or divergent, sometimes minutely mucronate at base; pollen prolate, 3-colpate to 3-colporate; staminode 1 (sometimes 0 or rarely 2–3), inconspicuous. Stigma bilobed with subequal or unequal lobes. Capsule estipitate, subellipsoid, retinacula absent or papilliform. Seeds numerous (–60), small, spheric to ellipsoid, reticulately ribbed or foveate.

TYPE: *Staurogyne argentea* Wallich.

Staurogyne agrestis Leonard, J. Wash. Acad. Sci. 27:400. 1937. TYPE: PANAMA. PANAMÁ: wet field between Matías Hernández and Juan Díaz, 21 Jan 1924, *Standley 31936* (HOLOTYPE: US!). (Fig. 1).

Sprawling perennial herbs to 3 dm long and 1.5 dm tall. Young stems terete to subquadrate, more or less evenly pubescent with flexuose eglandular trichomes to 2 mm long and straight to flexuose glandular trichomes 0.1–0.3 mm long. Leaves (plants sometimes leafless during anthesis) opposite, petiolate; petioles to 12 mm long; blades ovate to elliptic, 16–47 mm long, 9–22 mm wide, 1.6–2.3

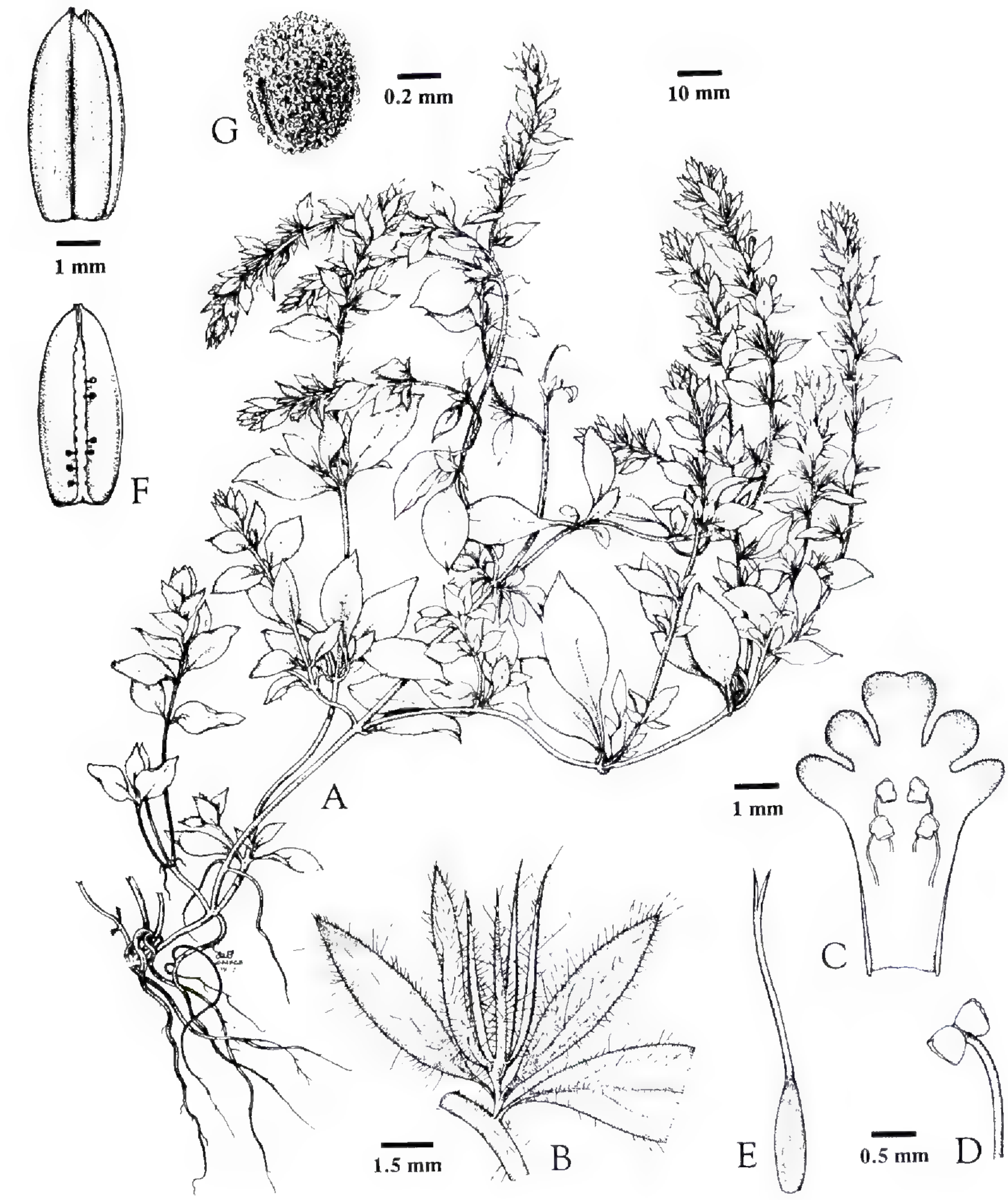

FIG. 1. *Staurogyne agrestis*. a. Habit (*Lott et al. 3396*). b. Inflorescence node (*Lott et al. 3396*). c. Corolla split open to show androecium (*Lott et al. 3226*). d. Stamen (*Lott et al. 3226*). e. Gynoecium (*Lott et al. 3226*), same scale as d. f. Capsule showing external surface of entire capsule, top, and internal surface of one capsule valve, bottom (*Lott et al. 3396*). g. Seed (*Lott et al. 3396*).
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times longer than wide, acute at apex, acute to attenuate at base, surfaces pubescent with cauline type trichomes, the trichomes becoming concentrated along major veins on larger leaves, margin entire or shallowly and irregularly sinuate-dentate. Inflorescence of loosely to densely bracteate axillary or terminal spikes to 90 mm long, 8–18 mm in diameter (measured flat) near midspike,

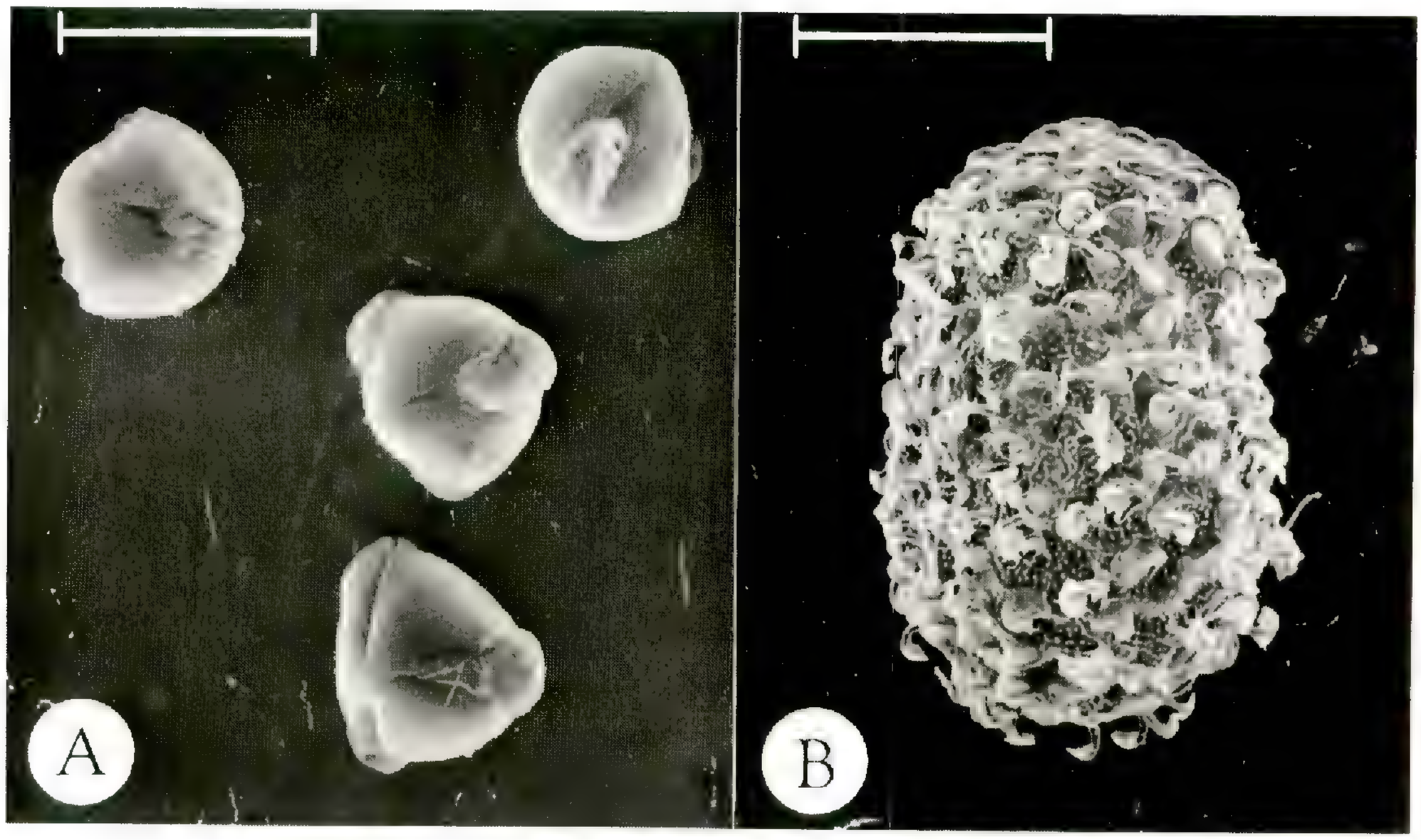

Fig. 2. Pollen and seed of *Staurogyne agrestis*. a. Pollen (*Lott et al. 3396*), scale equals 20 µm. b. Seed (*Lott et al. 3226*), scale equals 200 µm.

rachis pubescent like young stems; dichasia alternate, reduced to a single flower, sessile to subsessile in axils of reduced distal leaves or bracts, peduncles to 1 mm long; flowers subsessile, the pedicels to 0.8 mm long. Bracts elliptic, 6.5–11 mm long, 3–5 mm wide (proximal bracts often larger and foliose), subsessile or borne on a petiole to 1 mm long, acute at base, acute at apex, the abaxial surface and margin pubescent like young stems. Bractlets narrowly elliptic, often curved, 5–8 mm long, 1–1.6 mm wide, pubescent like bracts. Calyx 4.7–6.3 mm long, 5-lobed with lobes dissimilar, pubescent like bracts, the posterior lobe narrowly elliptic to oblanceolate, larger than the others, 4.5–6 mm long, 0.8–1.2 mm wide, the anterior lobes linear, 4–5.2 mm long, 0.4–0.5 mm wide, the 2 lateral lobes subulate, 3–4.3 mm long, 0.2–0.3 mm wide. Corolla white with a green throat, 4.5–7 mm long, externally pubescent with inconspicuous glandular trichomes 0.05–0.1 mm long, upper lip 1–1.3 mm long with rounded lobes 0.6–0.7 mm long, 0.6–0.8 mm wide, lower lip 1.5–2 mm long with lobes 0.7–1.3 mm long, 0.5–1 mm wide. Stamens 4, didynamous and inserted at different heights in corolla tube, the shorter pair inserted proximal to the longer pair, 1.2–1.3 mm long with thecae 0.3–0.4 mm long, the longer pair 1.4–1.5 mm long with thecae 0.4–0.5 mm long; pollen (mostly partially collapsed or irregular, Fig. 2) 3-colporate, the exine reticulate; staminode absent. Style 1.5–2.5 mm long, glabrous; stigma lobes 0.4 mm long. Capsule subellipsoid, 4.5–5 mm long, distal portion pubescent with glandular trichomes 0.05–0.1 mm long. Seeds (Fig. 2) ca. 40 per capsule, subellipsoid, 0.6–0.7 mm long, 0.4–0.5 mm wide, the surface papillate and covered with appressed or uncinate trichomes 0.05 mm long.

Phenology: Flowering and fruiting: January–May (throughout range; collected in flower and fruit in January and May in Mexico).

Distribution: Western Mexico (Guerrero (?) and Jalisco), Nicaragua, Costa Rica, Panama, and Venezuela (Fig. 2); Mexican plants occur along sandy washes in tropical subdeciduous forests at elevations near sea level and likely somewhat higher.

Additional specimens examined: MEXICO. **Jalisco:** Mpio. La Huerta, Rancho Cuixmala, rd. to Parque El Caiman, S side of Río Cuixmala, 19°25'N, 104°57'W, *Lott et al. 3226* (CAS, UCR); Mpio. La Huerta, Rancho Cuixmala, Río Cuixmala, ca. 0.5 mi downriver from headquarters, 19°23'N, 104°58'W, *Lott et al. 3396* (MEXU, UCR). **Guerrero (?):** "De Nueva España camino de la Venta de la Negra," *Neé (Exped. Malaspina) s.n.* (MA); "Acapulco camino de Mexico," *Neé (Exped. Malaspina) s.n.* (MA).

This rarely collected species was described from Panama and Nicaragua, recently documented from Costa Rica (Daniel 1993), and is here newly reported from Venezuela (Carabobo: Chirgua, 700 m, *Alston 5954*, US). A recent collection from coastal Jalisco extends the range of *S. agrestis* considerably northward into Mexico.

Although originally determined as unknown species of *Ruellia* and *Justicia*, two Mexican collections of Luis Neé from the Malaspina Expedition (1789 to 1794) at MA also represent this species. These collections reveal that the plant had apparently gone uncollected in western Mexico for nearly 200 years. One of the Neé collections contains an early label with the information "De Nueva España camino de la Venta de la Negra." Another Neé collection at MA, a specimen of *Dyssodia,* provides: "Venta de la Negra entra Acapulco y México." Venta de la Negra is shown on a map of the route taken by Antonio Pineda from Acapulco to Ciudad México in 1791 (Engstrand 1981:78). In the company of Neé and others, Pineda departed Acapulco on 8 May 1791 and traversed much of the route of the modern highway between Acapulco and Ciudad México. Venta de la Negra is shown along the route between "Amates" and "Palmillas." Modern maps of Guerrero show La Venta between Los Amates and Palmillas in northern Guerrero, ca. 10 km from the border with Morelos. The other collection of this species at MA is provided with four early labels with locality information as follows: "Acapulco camino de Mexico," "de Acapulco," "Chile," and "de Chile." A more recent label attempts to combine the locality information from these labels with "Acapulco, Chile." Although the Malaspina expedition visited both Chile and Mexico, this species has not since been found in the former country. Considering the unequivocal locality information on the other collection at MA, it seems most probable that this collection also came from southwestern Mexico between Acapulco and Ciudad México. Although the precise locality (or localities) of these collections remains unknown, the date of collection can be established as May of 1791 because Neé and the portion of Pineda's expedition that traveled via La Venta arrived in Ciudad México late in the month and their return was by a more easterly route (Engstrand 1981).

Staurogyne agrestis is morphologically similar to several South American species with small and white flowers. Standley's type specimen from Panama was originally identified as the Brazilian species *S. repens* (Nees) Kuntze and Bremekamp (1938) noted that among the six species of *Staurogyne* in Surinam, *S. stahelii* Bremekamp "comes very near to a plant recently described by Leonard as *S. agrestis*." *Staurogyne agrestis* differs from both of these species by its wider bracts and bractlets, larger leaves, and glandular pubescence. Other superficially similar South American species are *S. diantheroides* Lindau (which differs by its densely pilose pubescence in the inflorescence), *S. lepidagathoides* Leonard (which differs by its narrower bracts and bractlets and its eglandular stems), and *S. linearifolia* Bremekamp (which has narrower leaves).

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TAXONOMY OF *ANULOCAULIS* (NYCTAGINACEAE)

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ABSTRACT

The taxonomy of *Anulocaulis* (Nyctaginaceae: Nyctagineae) is reviewed. Five species, one with two varieties, are recognized: *A. annulatus* (Coville) Standl., *A. eriosolenus* (A. Gray) Standl., *A. gypsogenus* Waterf., *A. leiosolenus* (Torr.) Standl. var. *leiosolenus*, *A. leiosolenus* var. *lasianthus* I. M. Johnst., and *A. reflexus* I. M. Johnst.. The difference between *Anulocaulis* and *Boerhavia* includes habit, gross leaf features, perianth shape, and anthocarp morphology. Included is first report of chromosome numbers for the genus (n = 24 for *A. annulatus*, *A. eriosolenus*, *A. leiosolenus* var. *leiosolenus*).

RESUMEN

Se revisó la taxonomía del género *Anulocaulis* (Nyctaginaceae: Nyctagineae). Se reconocieron cinco especies, una de ellas con dos variedades: *A. annulatus* (Coville) Standl., *A. eriosolenus* (A. Gray) Standl., *A. gypsogenus* Waterf., *A. leiosolenus* (Torr.) Standl. var. *leiosolenus*, *A. leiosolenus* var. *lasianthus* I. M. Johnst., y *A. reflexus* I. M. Johnst.. En la discusión de las diferencias de *Anulocaulis* con el género *Boerhavia* se incluye el hábito, los caracteres distinctivos de las hojas, la forma del perianto, y la morfología del antocarpo. Así mismo se incluye el primer recuento de números cromosómicos para el género (*n* = 24 para *A. annulatus*, *A. eriosolenus*, y *A. leiosolenus* var. *leiosolenus*).

The arid regions of North America harbor one of the most diverse assemblages of Nyctaginaceae, 11 or 12 genera (as determined from counts in regional floras) of the 30 or so in the family (Cronquist 1981). Except for outlying populations of *Pisonia* in the tribe Pisonieae (subfamilial classification from Heimerl [1934]), all are in the tribe Nyctagineae (correct tribal and subtribal names reviewed by Bogle [1974]). About two thirds of these genera are endemic to the region (*Abronia*, *Tripterocalyx* in the subtribe Abroniinae and *Acleisanthes*, *Ammocodon*, *Anulocaulis*, *Cyphomeris*, *Nyctaginea*, *Selinocarpus*, which is restricted to the region except for one species in east Africa; all in the subtribe Nyctagininae). *Hermidium*, *Hesperonia*, *Oxybaphus* and *Quamoclidion*, segregate genera now considered by most modern floras to be part of a more broadly constructed *Mirabilis*, are also best developed in arid North America.

Anulocaulis, one of these endemic genera, has five species occurring from southern Coahuila in Mexico to southeastern California in the United States. Some of these are narrow endemics. Apparently the first collection of plants belonging to the present genus *Anulocaulis* was made by Gregg in 1848–49 in eastern Coahuila. This collection typifies *Boerhavia eriosolena*, named by Asa Gray

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in 1853. Between that date and 1909 two other species were added to this group, also as boerhavias, *B. leiosolena* Torr. (1858) from the Rio Grande Valley in western Texas and *B. annulata* Coville (1893) from Death Valley, California. These three species comprise a well-defined group of robust plants with broadly fusiform, turbinate, or biturbinate anthocarps that was recognized as the section *Solanenthae* by Heimerl (1889); general review by Fosberg (1978).

In 1909 Standley elevated Heimerl's section Solanenthae to generic rank, naming it *Anulocaulis*, in reference to the prominent sticky bands that encircle internodes, particularly the upper ones. Standley explained, "There is no good reason why plants which differ so markedly as these from typical Boerhaavias should be included in the genus *Boerhaavia*. [They]...may be separated at once by their distinct general appearance, due especially to their large, thick leaves [and erect robust habit], the shape of the perianth which has a distinct tube instead of being campanulate, and the 10-ribbed fruit of different shape" (pp. 374–375; comment in brackets mine). Standley (1911, 1918) maintained the genus and Heimerl (1934) adopted Standley's generic disposition of these species. Two species have been added to the genus since that time, both as *Anulocaulis*, *A. reflexus* by I. M. Johnst. (1944) and *A. gypsogenus* by Waterfall (1945).

In contrast, Fosberg (1978) maintained that *Anulocaulis* was part of a more inclusive *Boerhavia*, noting the difficulty of circumscribing *Boerhavia*, and discussing the merits of broader versus narrower generic delimitation with group. Nevertheless, he described four easily recognized groups of species within *Boerhavia*, one of which included only species otherwise recognized as *Anulocaulis*. This group was defined by features of habit, perianth limb, and lower portion of the perigone (= perianth), which is persistent around the achene or nut, the entire structure commonly called the anthocarp by most authors (including Cronquist, 1981). It is technically a diclesium as defined by Radford et al. (1974); Bogle (1974) discusses problems with term "anthocarp." The term is entrenched in descriptions of the Nyctaginaceae accessory fruit whereas the use of diclesium is not; I have opted to use the traditional term "anthocarp." In presenting an alternative argument to recognizing a large and diverse genus *Boerhavia*, Fosberg (1978) writes, "Those who find smaller, more coherent, simpler groups easier to remember and understand, to whom relationships are not as important as differences, or who are Nyctaginaceae specialists, may prefer to maintain the four genera" [*Anulocaulis*, *Boerhavia*, *Commicarpus*, *Cyphomeris*].

Authors of California floras (Abrams 1944; Jepson 1925; Munz and Keck 1959) have maintained the single California species of *Anulocaulis* in *Boerhavia*, but Spellenberg (1993) recognized it in *Anulocaulis*. With regard to fruit structure, this species does have an anthocarp of different shape from those of the remaining species of this small genus (Fig. 1-A, B), but it still does not strongly resemble the clavate, prominently 5-ridged anthocarp of *Boerhavia* (sensu stricto).

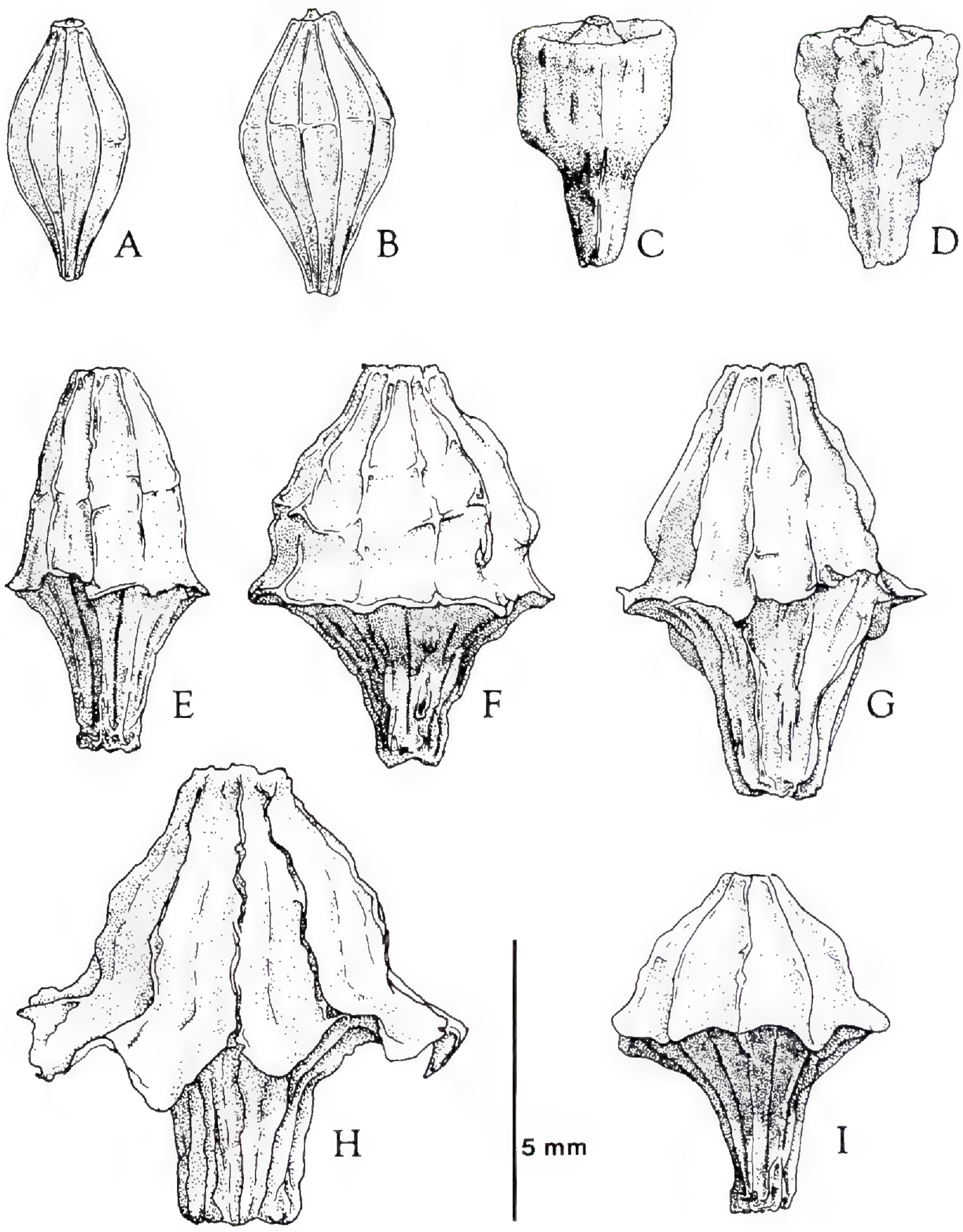

FIG. 1. Anthocarps of taxa of *Anulocaulis*. (A, B) *A. annulatus*, without (A) and with (B) equatorial ridge. (C, D) *A. eriosolenus* from northern (C) and southern populations (D). (E, F, G) *A. leiosolenus*; (E, F) var. *leiosolenus* from New Mexico (E) and Texas (F); (G) var. *lasianthus* from Texas. (H) *A. gypsogenus* from New Mexico. (I) *A. reflexus* from Chihuahua. Drawings from Spellenberg collections unless otherwise noted; collection numbers are: A, *3153*; B, *3152*; C, *9702*; D, *Henrickson 12536*; E, *9986*; F, *3469*; G, *3708*; H, *3667*; I, *3698*; specimens cited in appendix.

Authors of Southwestern floras have recognized *Anulocaulis* as distinct from *Boerhavia* (Correll and Johnston 1970; Kearney and Peebles 1960). Authors of all recent tropical floras that I have seen have also maintained *Commicarpus* distinct from *Boerhavia*.

Nowicke (1970, p. 87), in a survey of the pollen of the Nyctagineae, noted that differences in pollen morphology that correspond to generic alignment of species might be present, but were of a complex nature and to distinguish genera would require "detailed and tenuous choices based solely on numerical measurements." Qualitative differences were not detected. Chromosome number may support the distinction of *Anulocaulis*, since all counts for the genus have been $n = 24$; *Boerhavia* is variable, $2n = 26, 40, 42$, ca. 116 (Federov 1969), n = 26 (Fernandez Casas and Fernandez Piquieros 1981); $n = 26$ or 27 (Spellenberg, several unpublished counts). *Commicarpus* has been reported as $n = 20, 21$ (Bogle 1974; Spellenberg 1988). The simple nature of the perianth and anthocarp provides few characters and, along with the variability within species in this group of four genera (as noted by Fosberg [1978]), makes estimation of relationships tenuous. Modern molecular methods may be the key to understanding phylogenetic relationships in the tribe, and orienting character trends within it.

Since Standley's treatments of the Nyctaginaceae near the turn of the 20th century, and Heimerl's review of the family in 1934, the genus *Anulocaulis* has not been taxonomically treated in its entirety, although Reed's (1969) treatment for the Flora of Texas makes an approximation. The genus is readily divisible into two groups based on morphology of the perianth, including the anthocarp. The first group consists of two species whose distribution may represent a comparatively ancient separation, *A. annulatus*, restricted to low, hot elevations in and near Death Valley in the Mojave Desert, and *A. eriosolenus*, which has a bicentric distribution in the Chihuahuan Desert. They occur on various substrates. Both are similar in their rather smooth anthocarps (Fig. 1, A–D) that are usually non-mucilaginous when wetted (occasional collections of the latter from the southern part of the range secrete mucilage [Fig. 1-D]). Both also have foliage that bears large, dark, multicellular hairs, and both have small perianths with very villous tubes (Fig. 2-B, C), the latter a very unusual and perhaps unique characteristic in the family. Between these species, however, differences in anthocarp shape and ornamentation, greater than differences between species of the second group, argues also for a comparatively early divergence. *Anulocaulis gypsogenus*, *A. leiosolenus*, and *A. reflexus* form the tightly knit second group of robust perennials with fleshy gray-green leaves, perianths that are large and without villous hairs on the tube (Fig. 2-A, D), and anthocarps heavily ridged and wrinkled (Fig. 1, E–I) that secrete copious mucilage when wetted. All are strongly gypsophilic. That they are similar species in close geographic proximity on similar substrate suggests comparatively recent radiation.

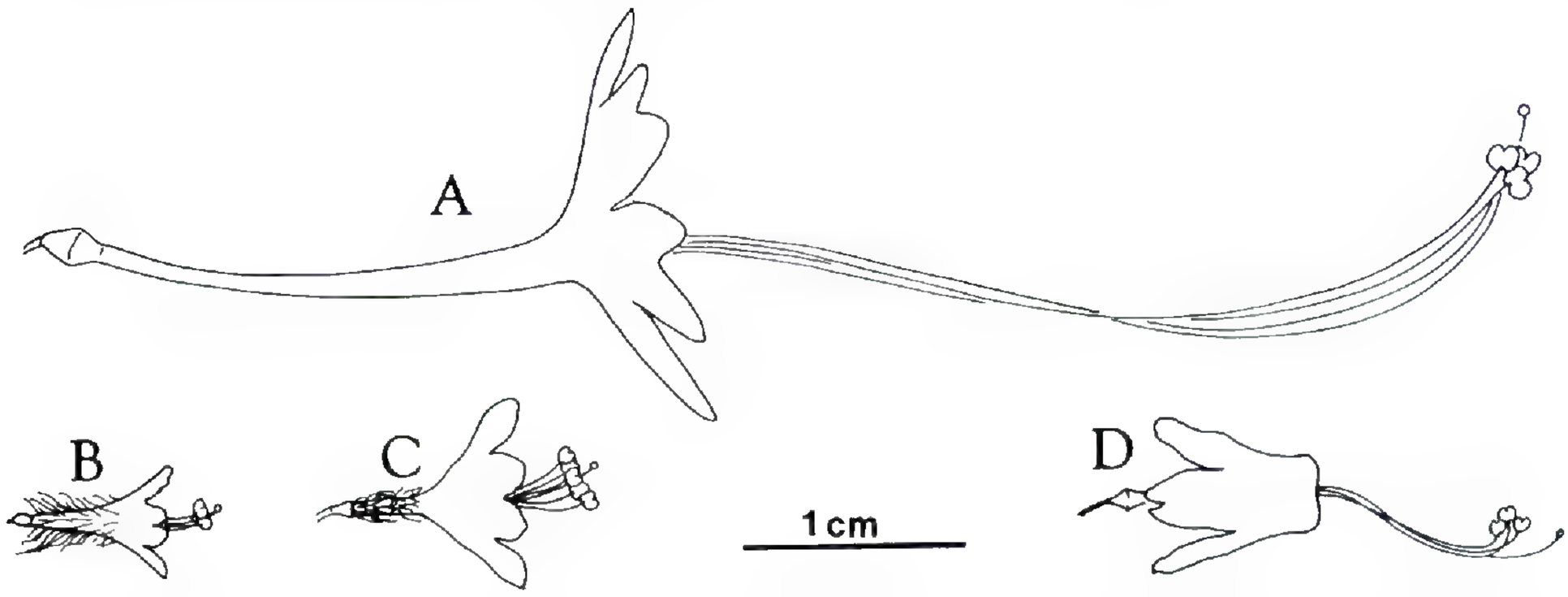

FIG. 2. Perianth form as viewed laterally in various species of *Anulocaulis* (all are drawn from Spellenberg collections, referenced by collection number, and cited in appendix). A. Representative of *A. gypsogenus* and *A. leiosolenus* (3469). B. *A. annulatus* (3149). C. *A. eriosolenus* (9693). D. *A. reflexus* (3698).

MATERIALS AND METHODS

All species were studied in the field, each on several occasions. Reports of insect floral visitors are based on personal observation. Chromosome numbers were determined from bud material examined by standard methods (cf. Spellenberg 1981); camera lucida drawings are filed with vouchers at NMC (see appendix). In all, 303 collections of the genus were examined. Characteristics presented in the following taxonomic descriptions were taken from these specimens except for features of the fragile perianth, which were supplemented by observations made in the field. Gratitude is expressed to curators of ARIZ, ASU, CAS, DUD, F, GH, NMC, NY, POM, RM, RSA, SRSC, TEX, UC, UNLV, US, UTEP who lent specimens and/or provided facilities for on site examination of specimens housed in those herbaria.

TAXONOMY

Anulocaulis Standl., Contr. U.S. Nat. Herb. 12: 374. 1909.

Perennials, often stout and robust with gnarled and spongy-woody roots, or of less duration with spongy roots, or occasionally even flowering as an annual. *Stems* usually stout, erect or ascending, divaricately branched, more or less pubescent. *Leaves* opposite, those of a pair slightly to strongly unequal, petiolate, borne in the lower half of the plant, or in one species more or less throughout; blades ovate or round to broadly reniform, leathery-succulent, glandular-denticulate or -crenulate, variously pubescent. *Inflorescence* widely and divaricately branched, with small scarious or coriaceous bracts. *Flowers* opening near sunset or during the night and closing by mid-day, the duration of anthesis a matter of hours, perfect, bracteate, umbellate, in axillary glomerules, or more or less racemose. *Perianth* funnelform, the tube elongate, constricted above the ovary, the

limb usually slightly zygomorphic, 5-lobed, the lobes emarginate. *Stamens* 3 or 5, exserted, often bent downward, then sweeping upward in a smooth arc; filaments filiform, more or less unequal, connate at the base; anthers didymous; pollen spheroidal, large (96–125 um), pantoporate, sexine spinulose and tubuliferous. *Pistil* unicarpellate; style filiform, positioned as the filaments, exserted slightly beyond the anthers; stigma peltate. Anthocarp broadly fusiform, turbinate, or biturbinate, indurate, 10-striate or -ribbed, often with an equatorial ridge or vestiges thereof, glabrous, exuding mucilage when wetted (in those anthocarps that bear prominent ridges or warts). Seed with the thin testa adherent to the pericarp; embryo uncinate; cotyledons broad, enclosing copious, chalky, mealy perisperm; radicle descending. *x* apparently = 24.

TYPE SPECIES: *Boerhavia eriosolena* A. Gray

KEY TO THE TAXA OF *ANULOCAULIS*

1. Perianth less than 1 cm long, tube externally villous; anthocarp without a prominent equatorial ridge or wing (sometimes faint in *A. annulatus*)
   2. Flowers ca. 5–15 in umbel-like clusters; tube of perianth not elongating markedly after anthesis; anthocarp broadly fusiform, with 10 narrow, well-defined linear ridges ..... 1. *A. annulatus*
   2. Flowers usually borne singly; tube of perianth markedly elongating after anthesis; anthocarp turbinate, bluntly 5-angled, ridges indefinite ..... 2. *A. eriosolenus*
1. Perianth ca. 1 cm long or longer, tube glabrous or at most very sparsely and minutely puberulent; anthocarp with a prominent equatorial ridge or wing
   3. Adaxial surface of leaves glabrous or glabrate, smooth, pale grayish greenwhen fresh; equatorial ridge or wing on anthocarp 0.8–1.2 mm wide ..... 5. *A. gypsogenus*
   3. Adaxial surface of leaves rough with (at least sparse) conical hairs or glandular tubercules; equatorial ridge or wing on anthocarp 0.2–0.6 mmwide
      4. Perianth 2.5–3.5 cm long, the lobes of the limb flared but notreflexed
         5. Distal part of perianth tube glabrous externally; flowers borne singly or in few-flowered clusters ..... 3. *A. leiosolenus* var. *leiosolenus*
         5. Distal part of perianth tube minutely puberulent externally; flowers usually in several-flowered glomerules ..... 4. *A. leiosolenus* var. *lasianthus*
      4. Perianth ca. 1 cm long, the lobes of the limb sharply reflexed at anthesis ..... 6. *A. reflexus*

1. **Anulocaulis annulatus** (Coville) Standl., Contr. U.S. Natl. Herb. 12:375. 1909. TYPE: UNITED STATES. CALIFORNIA. **Inyo Co.:** Funeral Mountains, Furnace Creek Canon, 8 Apr 1891, *Coville* 577 (HOLOTYPE: US!). *Boerhavia annulata* Coville, Contr. U.S. Natl. Herb. 4:177. 1893.

Strong perennial. *Stems* 1–8, erect or strongly ascending, branched in ca. upper 40% of plant with ascending branches of inflorescence, 0.5–2.0 m tall, to 1.5 cm diam. at base, glabrous or very sparsely pubescent with long septate hairs arising from blackish pustulate-glandular bases. *Leaves* in 4–6 pairs, decreasing in size slightly distally, and then abruptly, the uppermost leaves 5–10% the size of lower leaves, subtending lowest branches of inflorescence; basal and midstem leaves

with petioles 11–70 mm long, 2–5 mm wide; blades broadly ovate or almost reniform, 0.7–1.5 times as long as wide, 2–10 cm long, 2–9.5 cm wide; base from broadly rounded to truncate to shallowly or deeply cordate; apex rounded to broadly obtuse; margin irregularly crenulate-denticulate, densely beset with blackish-based hairs; adaxial surface yellow-green; abaxial surface glaucous, both surfaces and petiole villous-hirsute with transparent septate hairs that arise from a blackish pustullate-glandular base; adaxial surface less densely pubescent, the hairs especially dense on veins of abaxial surface. *Inflorescence* paniculate, forming ca. distal 40% of plant, ca. 1/2 as wide as long, branches ascending at 20–50°, the ultimate branchlets terminating in dense, capitate clusters of ca. 5–15 flowers; bracts of the inflorescence lanceolate, abaxially covered with blackish-purple blisters, coarsely ciliate with septate hairs on margins, those subtending branches greenish with purplish blisters, up to 5 mm long, those subtending individual flowers whitish with blisters, 1–3 mm long. *Perianth* (Fig. 2-B) from very pale pink (near white) to rose-pink, 9–10 mm long, funnelform, the tubular portion above swollen base ca. 2–3 mm long, evenly flared to a glabrous limb 3–6 mm wide; tube elongating after anthesis to 1.0–1.5 times length at anthesis, densely shaggy-hairy with coarse septate hairs 1–2.5 mm long. *Stamens* 3, exserted ca. 1–2 mm; filaments rose; anthers 0.6–0.7 mm long, yellow. *Style* exserted 4–5 mm, rose; stigma yellow. *Anthocarp* (Fig. 1-A, B) broadly fusiform, 3.5–6 mm long, 2.1–2.7 mm wide, the length from base to widest point 45–70% of total length; surface smooth, brownish-gray; sides of anthocarp with 10 low linear longitudinal ridges, and occasionally with a partial or complete very fine equatorial ridge; not secreting mucilage when wetted. Chromosome number $n = 24$.

Distribution: California in Inyo and north central San Bernadino cos. (Fig. 3); in hot desert canyons and on open slopes, in gravelly washes, on outwash fans, talus slopes, roadbanks from -70 to 1170 m; with *Larrea divaricata*, *Atriplex hymenelytra*, *Salvia funeria*, *Hymenoclea*, *Encelia*, *Tidestromia*, etc. Blooming from late February to late July, and occasionally weakly again in September, flowers opening about dawn and closing by mid-morning, visited by small bees, flies, and butterflies.

The anthocarp in *A. annulatus*, in its fusiform shape, differs most strongly from others in the genus. This, and that the flowers are borne in umbellate clusters, are probably reasons it has been considered a *Boerhavia* by many California floristicians. This is the only *Anulocaulis* where no mucilage is secreted by anthocarps of any plants tested. Mucilage exudes when warts and ridges break open in several arid-land Nyctaginaceae, including other *Anulocaulis* species and other genera that are considered closely related to *Anulocaulis* (all *Boerhavia* examined, all *Cyphomeris*, but no *Commicarpus*). The ten ridges are very fine in *A. annulatus*, and the occasional, incomplete equatorial ridge, may be a vestige remaining from reduction. It is not difficult to imagine a progression from an anthocarp such as

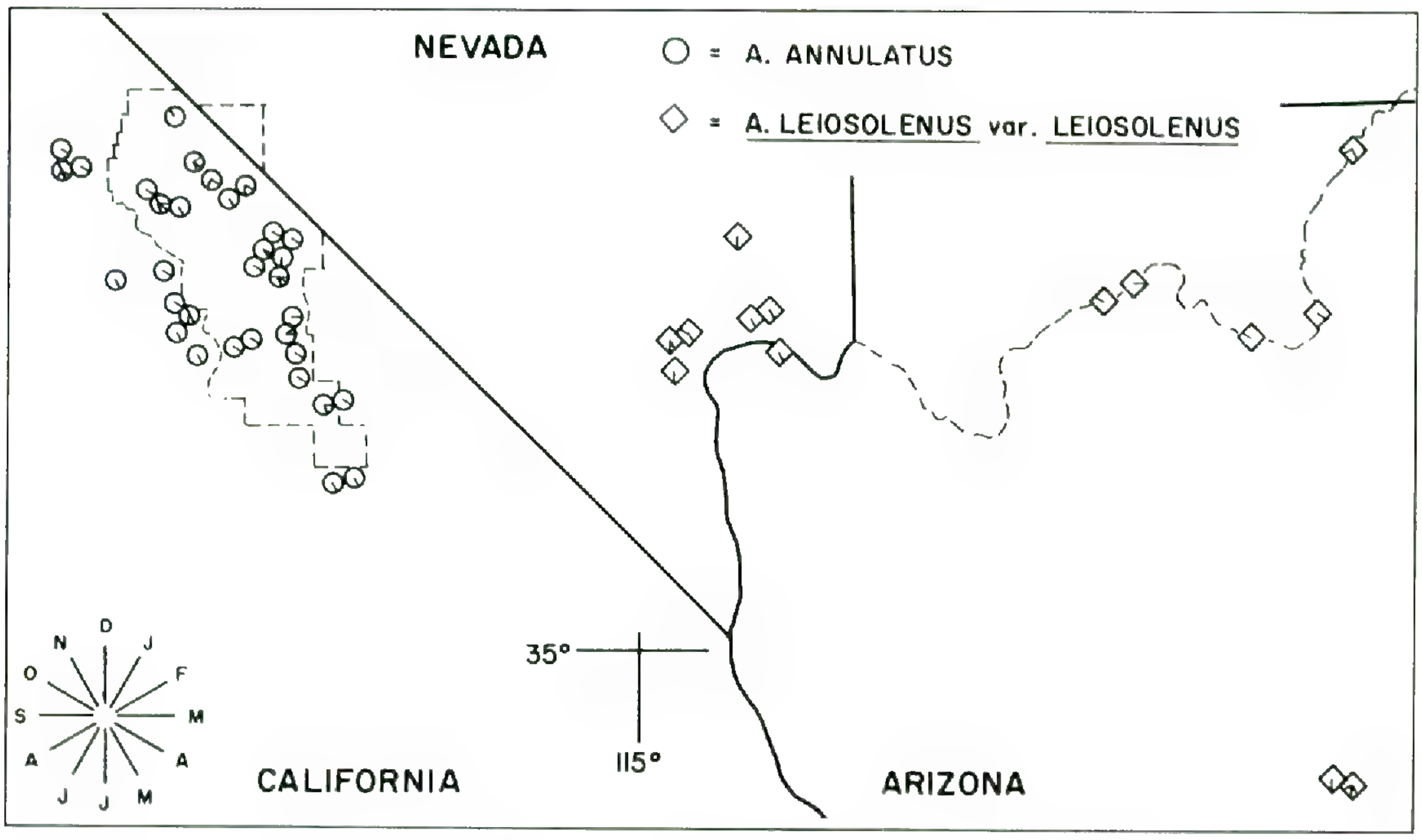

FIG. 3. Geographic distribution of *Anulocaulis annulatus* and *A. gypsogenus* in Arizona, California, and Nevada in the southwestern United States. Dotted line in Arizona represents the Colorado River; area outlined by dotted line in California and Nevada is Death Valley National Monument. Bar or bars within each figure on map represents a flowering collection; position the month it was made (key in lower left of figure). Some sites, or closely adjacent sites, produced several collections by same or different collectors over the decades; hence indication of multiple blooming dates.

that in Fig. 1-E (secretes mucilage) to that of Fig. 1-B (no mucilage secretion). Similarity in perianth pubescence suggests alliance with *A. eriosolenus* and chromosome number with other members of the genus in general.

2. **Anulocaulis eriosolenus** (A. Gray) Standl., Contr. U.S. Natl. Herb. 12:375. 1909. Type: MEXICO. COAHUILA: Azufrora near Saltillo, 1848–49, *Gregg 512* (HOLOTYPE: GH!; ISOTYPE NY!). *Boerhavia eriosolena* A. Gray, Amer. J. Sci. II 15:322. 1853.

Weak perennial, or perhaps sometimes annual. *Stems* 1–6, erect or widely ascending, branched in ca. upper 70% of plant with ascending branches of inflorescence, 0.2–1.8 m tall, to 1.5 cm diam. at base, glabrous. *Leaves* in 2–3 pairs; petioles 19–70 mm long, 2–5 mm wide; blades broadly ovate or more or less circular, 0.8–1.8 times as long as wide, 2–11.5 cm long, 1.7–13.5 cm wide; base usually shallowly cordate, occasionally ± truncate; tip rounded or obtuse; margin entire or irregularly crenulate, irregularly hispid with blackish-based hairs; adaxial surface yellow-green; abaxial surface very glaucous; both surfaces and petiole sparsely hirsute with white septate hairs that arise from a purplish pustullate-glandular base, the adaxial surface very sparsely pubescent, the hairs denser on the veins of the abaxial surface. *Inflorescence* paniculate, forming ca. distal 70% of plant, ca. as wide as long, branches ascending at 40-50°, the ultimate branchlets with ± distant flowers usually borne singly; bracts of inflorescence

lanceolate, glabrous except for minute cilia on margins of attenuate tip, those subtending branches blushed with maroon, ca. 2 mm long, those immediately subtending flowers 3–5 in number, translucent white with greenish midrib, 2–4 mm long. *Perianth* (Fig. 2-C) from white to pale pink, pale pink-lavender, or, especially in southern populations, deep rose-magenta, at anthesis 8–9 mm long, funnelform, the tubular portion above swollen base ca. 2–4 mm long, abruptly flared to a glabrous limb 6–11 mm wide; tube elongating after anthesis to 2.3–6.8 times length at anthesis, lanate with fine septate hairs ca. 1 mm long. *Stamens* 5, exserted ca. 4–6 mm; filaments pink; anthers 0.6–0.8 mm long, pale yellow. *Style* exserted 5–7 mm, deep pink; stigma yellowish. *Anthocarp* (Fig. 1-C, -D) turbinate, broadly and bluntly 5-angled, the top sunken slightly below irregularly rounded rim, 2.6–3.8 mm long, 2.4–3.4 mm wide, length from base to widest point 70–95% of total length; surface minutely pebbled, brownish-gray; sides of anthocarp faintly 10-veined (on and between angles), in southern populations occasionally secreting mucilage when wetted . Chromosome number $n = 24$.

Distribution: bicentric in the Big Bend region of Texas and adjacent Chihuahua and Coahuila, and in central and southern Coahuila (Fig. 4); in sand, on gravelly limestone outwash fans, in calcareous silty soils, or on gypsum; 600–1200 m; with *Larrea*, *Acacia*, *Jatropha*, *Fouquieria*, *Atriplex*, *Petalonyx*, *Opuntia*, etc. Blooming from late May early November, but mostly mid-summer and early fall, flowers opening at evening and closing by mid-morning, visited by small bees, flies, and butterflies. Plants have been described as biennial (or perennial), apparently first in Reed (1969) and repeated in Correll and Johnston (1970). They are definitely short-lived, but it is unlikely that these plants are strict biennials, that is requiring two years for maturation and then genetically programmed to die. Often in a population very small plants perhaps of only one year duration are in flower.

The Chihuahua Desert has been sufficiently collected at this point to assure that the gap in the distribution of this species in northeastern Coahuila (Fig. 4) is real. Apparently there has been minor, but inconsistent differentiation. No northern populations, and almost all southern populations, have not produced mucilage from wetted anthocarps. A very few southern populations, (e.g., Fig. 1-D) do from the warty bumps on the otherwise smooth anthocarp. This may represent a vestigial feature, the reasoning similar to that as discussed under *A. annulatus*. Collectors have noted the pink coloration in the perianth limb to be rather intense (even "red") in some collections from the southern part of the range; all collections from the Big Bend region of Texas are noted to be pale.

In all species of *Anulocaulis* the perianth tube often elongates slightly after anthesis and during maturation of the anthocarp, perhaps an overall effect of the enlargement of the perianth base. In *A. eriosolenus* the post-anthesis elongation is exaggerated. The significance can only be speculated upon at this point, but may

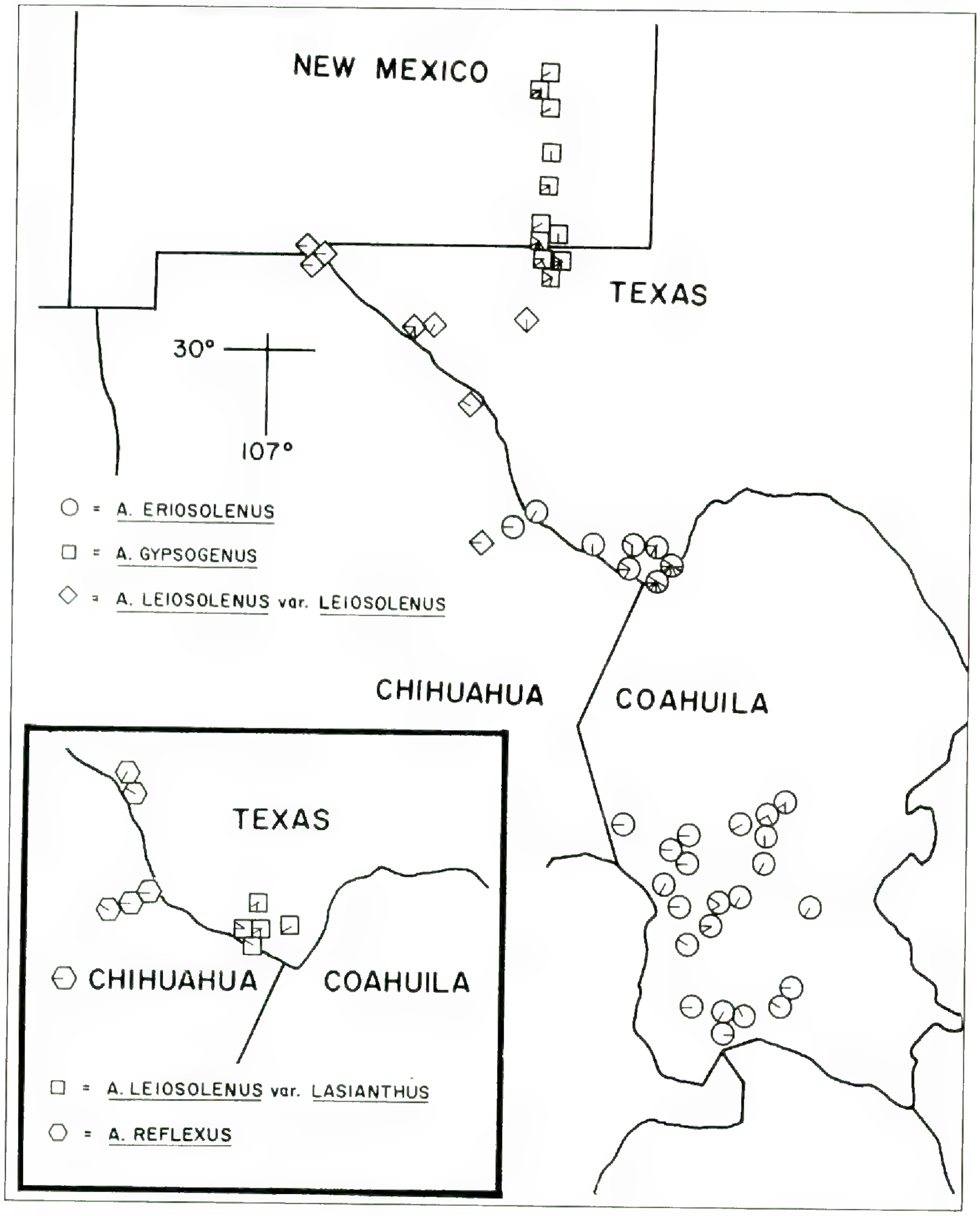

FIG. 4. Geographic distribution of *Anulocaulis eriosolenus*, *A. gypsogenus*, *A. leiosolenus*, and *A. reflexus* in New Mexico and Texas in the southwestern United States and in Chihuahua and Coahuila in northern Mexico. Explanation of bars within figures indicating location explained in Fig. 3.

also represent the dissociation of developmental process in response to selective pressure for general pollination by small insects (reduction of perianth), but outcrossing (long style) and post-pollination protection of the style from desiccation or other damage (elongating perianth tube).

3. **Anulocaulis leiosolenus** (Torr.) Standl.. var. **leiosolenus**, Contr. U.S. Natl. Herb. 12:375. 1909. TYPE: UNITED STATES: Great Canon of Rio Grande, *Parry 1139* (HOLOTYPE: GH!; ISOTYPES: NY, US, and apparently TEX (same number, but location as "Valley of the Rio Grande below Donana"). *Boerhavia leiosolena* Torr., Bot. Mex. Boundary, p. 172. 1858.

Acleisanthes nummularia M. E. Jones, Contr. W. Bot. 10:43. 1902. TYPE: UNITED STATES. TEXAS: El Paso, 12 Sep 1884 (HOLOTYPE: POM! [but dated only "Sept. 1884"; ISOTYPES: NY!, US! (fragment of type without location or date). *Boerhavia nummularia* (M. E. Jones) M. E. Jones, Ind. Kew Suppl. 4:27. 1913. Jones (1902), in describing *Acleisanthes nummularia*, indicated the type to be from "El Paso, Texas, Sept. 12, 1884," and customary of the time did not indicate deposition of a holotype. Reed (1969), placing *Acleisanthes nummularia* into synonymy of *Anulocaulis leiosolenus* var. *leiosolenus*, indicated the specimen US-865608 to be the type for the former name, effectively lectotypifying the name, probably unintentionally. The US specimen consists of a single leaf, and has no data associated with it other than the name of the plant and "Fragment of the type." I consider the specimen at POM to be the holotype, the herbarium receiving Jones's personal collection (Lenz 1986, p. 174).

Strong perennial, from gnarled woody root. *Stems* 1–6, erect or ascending, branched ca. in upper 70% of plant with ascending branches of inflorescence, 0.5–1.5 m tall, to 1 cm diam. at base, glabrous, notably glaucous. *Leaves* in 1–3 pairs in the basal 1/4 of plant, the uppermost very much reduced and subtending lowest branches of inflorescence; larger leaves with petioles 2.5–7.5 cm long, 3–6 mm wide; blades broadly ovate or more or less orbicular, 0.8–1.2 times as long as wide, 5–15.5 cm long, 4–19 cm wide; base usually shallowly or deeply cordate, rarely broadly rounded; apex rounded to broadly obtuse; margin irregularly crenulate, glabrous; adaxial surface dull green; abaxial gray-green; both surfaces beset with pale purplish pustules, pustules and epidermis between pustules with fine hairs often several in a cluster when young, deciduous later, the pustules considerably denser on abaxial surface. *Inflorescence* widely paniculate, forming ca. distal 75% of plant, ca. as wide as long, branches ascending at 40-65°, the branchlets bearing in distal portion well-spaced flowers borne mostly singly; bracts of the inflorescence broadly lanceolate, blackish-purple, glabrous or sparsely short-ciliate on margin, 2–3 mm long; 1 minute bract immediately subtending flower. *Perianth* (Fig. 2-A) greenish-bronze on tube, white or very pale pink on limb, ca. 2.5–3.5 cm long, the tube above the swollen base 19–28 mm long, the limb abruptly flared, 11–25 mm wide, the notches between the lobes ca. 2–5 mm deep, the tube and limb glabrous; tube after anthesis 1.0–1.1 times length at anthesis. *Stamens* 3, exserted ca. 2.5–4 cm; filaments magenta; anthers 1–1.3 mm long, yellow. *Style* exserted 3–5 cm, about 1 cm beyond anthers, magenta; stigma yellow. *Anthocarp* (Fig. 1-E, -F) biturbinate, 4.2–6.8 mm long, 2.6–4.6 mm wide, length from base to widest point 40–55% of total length where there is a slightly deflexed, ± wavy, equatorial skirtlike wing 0.2–0.6 mm long, the basal part of anthocarp flared from a stipe-like base, the upper part ± hemispheric; surface between ridges and wrinkles smooth, pale gray or grayish-tan; sides of anthocarp with 10 irregular longitudinal ridges and often smaller

longitudinal wrinkles between, secreting extensive mucilage when wetted. Chromosome number $n = 24$.

Distribution: bicentric, occurring on calcareous Cretaceous shales and clays near the Rio Grande in northeastern and north central Chihuahua, in western Texas, and in southcentral New Mexico (Fig. 4); 1010–1160 m; with *Acacia neovernicosa*, *Hilaria*, *Larrea*, *Yucca torreyi*; also on alkaline clay bluffs and gypsum along and near the Colorado River in northwestern Arizona and southern Nevada (Fig. 3); 400–1010 m; with *Arctomecon*, *Atriplex confertifolia*, *Canotia*, *Larrea*, *Petalonyx*, *Prosopis*, *Psathyrotes*, *Salazaria*. Blooming from May to June, and again in October in Arizona and Nevada populations, June through September in Chihuahuan Desert populations, flowers opening at about sunset and closing by mid-morning, visited by sphingid moths.

The completely disjunct and geographically distant western populations (cf. Figs. 3, 4) are vegetatively identical to those of the Chihuahuan Desert region, and differ little if at all with respect to anthocarp, which resembles closely the anthocarp pictured in Fig. 1-F. Fresh flowers that I have observed in the western populations, in central Arizona and in southern Nevada, have been paler (white or nearly so) in contrast to the pale pink perianths of eastern plants, and the limb in western populations is broader, usually 18–25 mm broad (vs. 12–18 mm). The western populations may be racially recognizable on perianth features alone. Features of flowers, however, are rarely noted on herbarium specimens; flowers are truly ephemeral and fragile, pressing poorly if collected. There seems little utility in distinguishing the western race. The small population recently rediscovered in extreme south-central New Mexico and adjacent Chihuahua also shows minor differentiation, its anthocarps beomg proportionately narrower (Fig. 1, E). Such minor differences would be expected in species that have small populations in an island-like distribution.

4. **Anulocaulis leiosolenus** (Torr.) Standl. var. **lasianthus** I. M. Johnst., J. Arnold Arbor. 25:175. 1944. TYPE: UNITED STATES. TEXAS. **Brewster Co.:** 5.25 mi E of Terlingua, 24 Sep 1938 (HOLOTYPE: GH!).

Similar vegetatively and in fruit (Fig. 1, G) to the var. *leiosolenus*, but differing in aspects of the inflorescence and perianth, as follows: *Flowers* borne on short side branches and terminal branches, ± congested, 1–6 in anthesis in any one cluster at a time. *Perianth* pinkish-greenish-bronze on tube, pale pink to pink on limb, ca. 2.5–3.5 cm long, the tube above the swollen base 19–25 mm long, the limb abruptly flared, 15–24 mm wide, the notches between the lobes ca. 2–3 mm deep, the upper portion of tube minutely and often sparsely villous; tube after anthesis 1.0–1.2 times length at anthesis.

Distribution: Restricted to clay and clayey shale deposits in the Big Bend region of Texas in Brewster and Presidio counties and immediately adjacent northeastern Chihuahua (Fig. 4); 820–950 m; with *Acacia*, *Acleisanthes*, *Agave lecheguilla*,

Dasylirion, *Gutierrezia*, *Larrea*, *Selinocarpus*. Blooming from late May to mid-October, the flowers opening at sunset and closing by following mid-morning and visited by wasps, bumblebees, and sphingid moths.

5. **Anulocaulis gypsogenus** Waterf., Rhodora 47:329–332. 1945. TYPE: UNITED STATES. NEW MEXICO. **Chaves Co.**: Comanchean Bluffs, 7 mi E of Roswell, 9 Oct 1944, *Waterfall 5701* (HOLOTYPE: GH!; ISOTYPES: NY! MO!). The holotype consists of two herbarium sheets, one showing the base of the plant and a portion of the inflorescence, the second having only the inflorescence. The second sheet appears to have been prepared at the time of mounting the first, and the inflorescence seems to be from the plant mounted on the first sheet.

Strong perennial, from gnarled woody root. *Stems* 1–5, erect or ascending, branched in ca. upper 70% of plant with ascending branches of inflorescence, 0.6–1.5 m tall, to 1.5 cm diam. at base, glabrous and notably glaucous. *Leaves* in 1–3 pairs in the basal 1/4 of plant, the uppermost very much reduced and subtending lowest branches of inflorescence; larger leaves with petioles 5–10 cm long, 5–8 mm wide; blades broadly ovate or more or less circular, 0.7–1.2 times as long as wide, 4–19 cm long, 3–23 cm wide; base from broadly rounded to shallowly or deeply cordate; apex rounded to broadly obtuse; margin irregularly wavy, glabrous; adaxial surface pale gray-green; abaxial surface much paler, whitish gray-green; both surfaces virtually glabrous or sparsely beset with whitish or pale purplish pustules that occasionally bear a whitish trichome, the stomates conspicuous as dark punctae on a pale background. *Inflorescence* widely paniculate, forming ca. distal 75% of plant, ca. as wide as long, branches ascending at 35-60°, the ultimate branchlets bearing distantly or closely spaced flowers borne singly or in few-flowered compact short branchlets; bracts of the inflorescence broadly lanceolate, blackish-purple, glabrous, 2–3 mm long; 1 minute bract immediately subtending flower. *Perianth* (Fig. 2-A) pale reddish-green or bronze on tube, the limb white or very pale pink, ca. 3 cm long, the tube above the swollen base 21–28 mm long, the limb abruptly flared, 18–20 mm wide, the notches between the lobes ca. 6 mm deep, tube and limb glabrous; tube after anthesis 1.0–1.1 times length at anthesis. Stamens 3, exserted ca. 3–3.5 cm, filaments magenta, anthers 1–1.3 mm long, yellow. Style exserted 4–5 cm, about 1 cm beyond anthers, magenta; stigma yellow. *Anthocarp* (Fig. 1-H) biturbinate, 6–8 mm long, 3–4.5 mm wide, length from base to widest 40–60% of total length, at widest point there is a slightly deflexed, ± wavy, equatorial skirtlike wing 0.8–1.2 mm long, the basal part of anthocarp flared from a stipe-like base, the upper part ± hemispheric; surface between ridges and wrinkles smooth, pale gray to nearly white; sides of anthocarp with 10 irregular longitudinal ridges and often irregular longitudinal wrinkles between, secreting extensive mucilage when wetted.

Distribution: along the Pecos River in southeastern New Mexico, barely entering western Texas (Fig. 4), on gypsum outcrops; 1000–1400 m; with other

gypsophiles such as *Coldenia hispidissima*, *Nerisyrenia linearifolia*, *Selinocarpus lanceolatus*, *Sporobolus neallyi*. Blooming mid-May to early October, flowers opening at about sunset and closing by following mid-morning and visited by wasps, pollen-collecting bees, and sphingid moths.

Anulocaulis gypsogenus has a comparatively large and very pale perianth similar to that of the western race of *A. leiosolenus* var. *leiosolenus*. It also has the largest anthocarps with the most prominent ridges and wings (Fig. 1-H). Its northernmost locality is north of Roswell, Eddy Co., New Mexico (Waterfall 1946).

6. **Anulocaulis reflexus** I. M. Johnst., J. Arnold Arbor. 25:175–176. 1944. TYPE: MEXICO. CHIHUAHUA: 10 mi S of Ojinaga, 8 Aug 1940, *Johnston & Muller 10* (HOLOTYPE: GH!; ISOTYPE: F!).

Strong perennial, from gnarled woody root. *Stems* 1–6, erect or ascending, branched throughout with ascending branches, 0.3–1.2 m tall, to 1 cm diam. at base, glabrous and glaucous. *Leaves* in 2–3 pairs in the basal 1/3 of plant, the uppermost very much reduced and subtending lowest branches of inflorescence, larger leaves with petioles 1–8.5 cm long, 2–4 mm wide; blades broadly ovate, more or less circular, or reniform, 0.8–1.2 times as long as wide, 3–12 cm long, 3–14 cm wide; base shallowly or deeply cordate, apex rounded, margin irregularly wavy, glabrous; adaxial surface gray-green; abaxial surface paler, gray-green; both surfaces beset pale purplish spots that on young leaves are ± pustulate and bear 1-several minute crinkled whitish trichomes. *Inflorescence* widely paniculate, forming ca. distal 70% of plant, ca. as wide as long, branches ascending at 30-50°, the ultimate branchlets bearing distantly spaced flowers borne singly; bracts of the inflorescence broadly lanceolate, blackish-purple, sparsely ciliate on margins of attenuate tip, 1–2 mm long; 1 minute bract subtending flower. *Perianth* (Fig. 2-D) yellow green on tube and throat, the lobes of the limb pink or rose, ca. 9 mm long at anthesis; tube above the swollen base 6–8 mm long, the limb abruptly reflexed, 7–8 mm wide, the notches between the lobes ca. 1 mm deep, tube and limb glabrous, tube after anthesis 1.5–2.2 times length at anthesis. *Stamens* 3, exserted ca. 1–1.4 mm; filaments rose or pale dull orange; anthers 1 mm long, rusty orange. *Style* exserted 1.5–2 cm, about 5 mm beyond anthers, magenta; stigma yellow. *Anthocarp* (Fig. 1-I) biturbinate, 6–6 mm long, 2.5–3 mm wide, length from base to widest point 50–60% pf total length where there is a slightly deflexed, ± wavy, equatorial skirtlike wing 0.2–0.3 mm long, the basal part of anthocarp flared from a stipe-like base, the upper part ± turbinate; surface between ridges and wrinkles smooth, pale tannish gray; sides of anthocarp with 10 prominent irregular longitudinal ridges and often much smaller longitudinal wrinkles between, secreting extensive mucilage when wetted.

Distribution: mostly near the Rio Grande west of the Big Bend in Jeff Davis and Presidio cos., Texas, and in adjacent Chihuahua south of Ojinaga, primarily on shaley gypseous clays; 800–1150 m; with *Larrea* (Fig. 4). Blooming mid-May to

mid-October, the flowers opening before dawn and closing by following mid-afternoon and visited by various bees.

The perianth in *A. reflexus* in its contrasting colors and reflexed lobes, may have been modified from a more tubular type in response to selective pressures for general diurnal pollination. Reed (1969) noted the top half of the anthocarp to have 10 ribs, the lower to have 5; this difference is not apparent in material that I have seen (Fig. 1-I).

APPENDIX

Representative specimens for taxa of *Anulocaulis*.

Anulocaulis annulatus (87 collections seen): UNITED STATES. CALIFORNIA. **Inyo Co.:** Furnace Creek Wash, Funeral Mts, 13 Jun 1930, *Ferris 8000* (DUD, GH, RM, NY, RSA, UC, US); Death Valley, Funeral Mts, 8 Apr 1907, *Jones s.n.* (CAS, DUD, F, POM); Saline Valley, mouth of Beveridge Canyon, 24 Nov 1954, *Roos & Roos 6261* (RSA, UC); Death Valley, Artist's Drive, 18 May 1973, *Spellenberg 3152* (NMC–chromosome count voucher; Death Valley Nat. Mon., 14 mi S of Badwater, 18 May 1973, *Spellenberg 3153* (MEXU, NMC, NY, RSA, UTEP). **San Bernardino Co.:** 4 mi NW of Avawatz Pass in Avawatz Mts, *Henrickson 17192* (NMC, RSA); S of Death Valley at Avawatz Salt and Gypsum Mine, *Spellenberg 3149* (MEXU, NMC, NY).

Anulocaulis eriosolenus (73 collections seen): MEXICO. **Chihuahua:** 7 mi S of Ojinaga on road to Chihuahua, 15 Sep 1973, *Spellenberg 3701* (MEXU, NMC, NY). **Coahuila:** 10.7 mi SW of El Sol on Rte. 40, 6 Jul 1972, *Chiang et al. 281* (CAS, NMC); 64 (rd) mi W of Cuatro Cienegas, in Bolson de Mapimi, 21 Sep 1972, *Henrickson 7862* (NMC); Torreon-Saltillo Highway, 55 mi W of Saltillo, 15 Sep 1938, *I. M. Johnston 7701* (GH); Highway 30 26 mi NW of San Pedro, 1 Sep 1975, *Spellenberg & Willson 4048* (CIIDIR, MEXU, NMC, NY).

UNITED STATES. TEXAS. **Brewster Co.:** Big Bend National Park, just N of Mariscal Canyon, 13 Sep 1961, *Correll & Johnston 24563* (GH, TEX); Chisos Mts, 2 mi NW of Boquillas, 20 Jul 1936, *Marsh 146* (ARIZ, F, GH, UC); Hot Springs, 13 Jul 1951, *Moore & Steyermark 3456* (CAS, DUD, GH, NY, UC); about 75 mi S of Alpine, 28 Jun 1971, *Powell 2177* (NMC, TEX–chromosome count voucher); 2 mi W of Study Butte, 22 Jun 1971, *Spellenberg & Moore 2615* (NMC, NY–chromosome count voucher).

Anulocaulis gypsogenus (46 collections seen): UNITED STATES. NEW MEXICO. **Chaves Co.:** E side of Pecos River E of Roswell, 25 Jul 1973, *Spellenberg 3426* (MEXU, NMC, NY, RSA, UNM); E of Pecos River 1/2 mi S of Fraler, 27 Aug 1945, *Waterfall 6131* (GH, NY, TEX). **Eddy Co.:** 3 mi N of Texas border on US Highway 62-180, 30 Aug 1985, *Spellenberg & Spurrier 8254* (NMC, NY); 8 air mi SSE of White's City, Hay Hollow, 10 Jun 1986, *Spellenberg & Spurrier 8507* (NMC, NY); near Texas state line, Hwy 62, 22 Aug 1941, *Strandtmann 6* (GH, SRSC, TEX). TEXAS. **Culberson Co.:**; N side of Delaware Creek, 1 Jul 1958, *Correll & I. M. Johnston 19098* (NY); 20 mi N of Frijole, hwy to Orla, 5 Jul 1947, *Warnock 6245* (SRSC, TEX). **Loving Co.:** N of Orla near Hwy 285 near and above Salt Creek, 27 Sep 1962, *Correll & Correll 26022* (GH, TEX). **Reeves Co.:** Screw Bean Arroyo, 56 mi N of Pecos, 22 Aug 1942, *Waterfall 4258* (ARIZ, GH).

Anulocaulis leiosolenus var. **lasianthus** (27 collections seen): MEXICO. **Chihuahua:** Mina las Marias on Mesa de Anguila, 3 Oct 1972, *Chiang, Wendt, Johnston 9681* (CAS, NMC, NY).

UNITED STATES. TEXAS. **Brewster Co.:** road to Agua Fria Mtn., 5.6 mi W of Hwy 118, 26 May 1984, *Powell & Powell 4345* (SRSC); 3.6 mi W of Terlingua, 16 Sep 1973 (MEXU, NMC, NY, RSA), 7 mi N of old Terlingua on Texas Co. Rd. 170, 3 Sep 1988, *Spellenberg & Ward 9704* (NMC). **Presidio Co.:** 5 mi from Lajitas on road to Presidio, 26 Oct 1959 *Correll 23354* (TEX);

hwy between Lajitas and Arroyo Segundo, Fresno Canyon, 23 Aug 1949, *Warnock & Turner 1342* (SRSC).

Anulocaulis leiosolenus var. **leiosolenus** (54 collections seen): MEXICO. **Chihuahua:** 5 km E of Rancho Cieneguillas, across Rio Grande from S part of Eagle Mts, Texas, 26 Oct 1972, *Chiang et al. 9906* (NMC, CAS); on W side of Rio Grande ca. 10 m S of U.S. border at Monument 1, 3 Sep 1989, *Spellenberg et al. 9985* (MEXU, NMC, NY, TEX).

UNITED STATES. ARIZONA. **Coconino Co.:** Colorado River, Marble Canyon, mouth of 19 Mile Canyon, 6 May 1971, *Holmgren et al. 15570* (NY). **Mojave Co.:** Grand Canyon Nat. Pk., mile 175L, 13 Oct 1978, *Phillips & Phillips 78-779* (UNLV). **Yavapai Co.:** 4 mi E of Camp Verde, 24 Jun 1939, *Peebles 14411* (ARIZ, CAS, GH, UC, US). NEVADA: **Clark Co.:** near Glendale, 28 Jun 1933, *Eastwood 1291*, (CAS, F); ca. 10 mi E of Las Vegas near Gypsum Cave, 19 May 1973, *Spellenberg 3172* (NMC, NY). NEW MEXICO. **Doña Ana Co.:** on W side of Rio Grande ca. 3/4 mi N of Mexican border, 3 Sep 1989, *Spellenberg et al. 9986* (NMC). TEXAS. **Culberson Co.:** Rio Grande floodplain 25 mi about Indian Hot Springs, 29 Sep 1963, *Warnock 19309* (SRSC). **El Paso Co.:** vicinity of El Paso, 1911, *Stearns 175* (F, US). **Hudspeth Co.:** 13.5 mi N of Indian Hot Springs, 11 Aug 1973, *Spellenberg 3469* (MEXU, RSA, NMC, NY–chromosome count voucher); Finley, 12 Jul 1943, *Waterfall 5026* (CAS, GH, NY). **Presidio Co.:** just E of San Carlos Creek ca. 1 mi N of Weatherford's ranch house, 11 Jun 1941, *Hinckley 1665* (ARIZ, NY, US).

Anulocaulis reflexus (16 collections seen): MEXICO. **Chihuahua:** 7.5 mi S of Ojinaga on road to Chihuahua, 15 Sep 1973, *Spellenberg 3698* (MEXU, NMC); ca. 26 air mi NE of Julimes, 16 Sep 1973, *Henrickson* 13016 (NMC).

UNITED STATES. TEXAS. **Jeff Davis Co.:** ca. 11 mi SW of Chispa, S end of Van Horn Mts, 26 Jul 1943, *Waterall 5296* (GH). **Presidio Co.:** just E of San Carlos Creek, 1 mi N of Weatherford's, 23 Sep 1940, *Hinckley 1665* (GH, NY, TEX).

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THE 1993 DELZIE DEMAREE TRAVEL AWARD

An endowment to underwrite an annual travel award ($250) in memory of Dr. Delzie Demaree is given annually to a graduate student in systematics for travel to the Systematics Symposium sponsored each fall by the Missouri Botanical Garden in St. Louis. Such an award is a very appropriate way to honor Dr. Demaree and to continue his legacy of assistance to students of botany.

Tim McDowell, a graduate student of Donald E. Stone at Duke University, Durham, North Carolina, is the 1993 recipient of the fifth annual Delzie Demaree Travel Award. His dissertation is focused on a monographic and evolutionary study of the neotropical genus *Exostema* (Rubiaceae), which comprises some 35 woody species, concentrated in the Greater Antilles. Attendance at the Systematics Symposium will provide Tim with an outstanding opportunity to participate in the International Conference on the Systematics of the Rubiaceae, scheduled the same week at the Missouri Botanical Garden.

NEW JOURNAL

RHEEDEA. Official Journal of Indian Association for Angiosperm Taxonomy. (ISSN 0971-2313). Published half-yearly in June and December. Subscriptions: The Treasurer, IAAT, Department of Botany, University of Calicut, INDIA. Selected articles from the recent issue 2(2): 1992: KUMAR, C.S. and K.S. MANILAL. Ephiphytic Orchids of India. RAVI, N. and N.A. KUMAR. New and Interesting Species of *Dimeria* R. Br. (Poaceae) from Kerala, India. FRYXELL, P.A. A Revised Taxonomic Interpretation of *Gossypium* L. (Malvaceae).

FOLIAR TRICHOME VARIATION IN *QUERCUS* SECTION *PROTOBALANUS* (FAGACEAE)

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ABSTRACT

Foliar trichomes of *Quercus* section *Protobalanus*, the smallest section of the oaks, were studied using scanning electron microscopy. Distinct complements of non-glandular trichome types were observed for each of the five recognized species (*Q. cedrosensis* C.H. Müll., *Q. chrysolepis* Liebm., *Q. palmeri* Engelm. [*Q. dunnii* Kell.], *Q. tomentella* Engelm., and *Q. vaccinifolia* Kell.). Trichome characters fully support the current taxonomy of the section and provide additional characters for species identification. Intraspecific trichome variation was used to address both geographic variation and hypotheses of hybridization between several species-pairs. Contrary to previous reports, the total complement of non-glandular trichomes documented in section *Protobalanus* is as diverse as that observed in both the larger red (black) and white oak groups.

RESUMEN

Se estudiaron, mediante el microscopio electrónico de barrido, los tricomas foliares de *Quercus* sección *Protobalanus*, que es la sección más pequena de los robles. Se observaron distintas cantidades de tipos de tricomas no glandulares en cada una de las cinco especies (*Q. cedrosensis* C.H. Müll., *Q chrysolepis* Liebm., *Q. palmeri* Engelm., [*Q. dunnii* Kell.], *Q. tomentella* Engelm., y *Q. vaccinifolia* Kell.). Los caracteres de los tricomas apoyan la taxonomía aceptada de la sección y ofrecen caracteres adicionales para la identificación de especies. La variación intraespecífica de los tricomas se uso tanto para explicar la variación geográfica como para hacer hipótesis de hibridación entre varios pares de especies. Contrariamente a lo que se había citado previamente, la cantidad total de tricomas no glandulares en la sección *Protobalanus* es tan diversa como la observada en los grandes grupos de robles blancos y rojos (negros).

INTRODUCTION

Foliar trichomes provide a valuable set of analytical characters for species delimitation in *Quercus*. The use of trichome characters in *Quercus* dates back to the taxonomic studies of Camus (1936–54) and Dyal (1936), and their widespread application to oak taxonomy has increased through the use of scanning electron microscopy (SEM; e.g. Hardin 1975, 1976, 1979a, 1979b; Nixon & Steele 1981; Thomson & Mohlenbrock 1979). Many of the trichome differences visible under the SEM also are discernible with standard light microscopy (LM) or even a hand lens, but certain cryptic morphological differences, such as attachment of trichome rays, are better observed with SEM.

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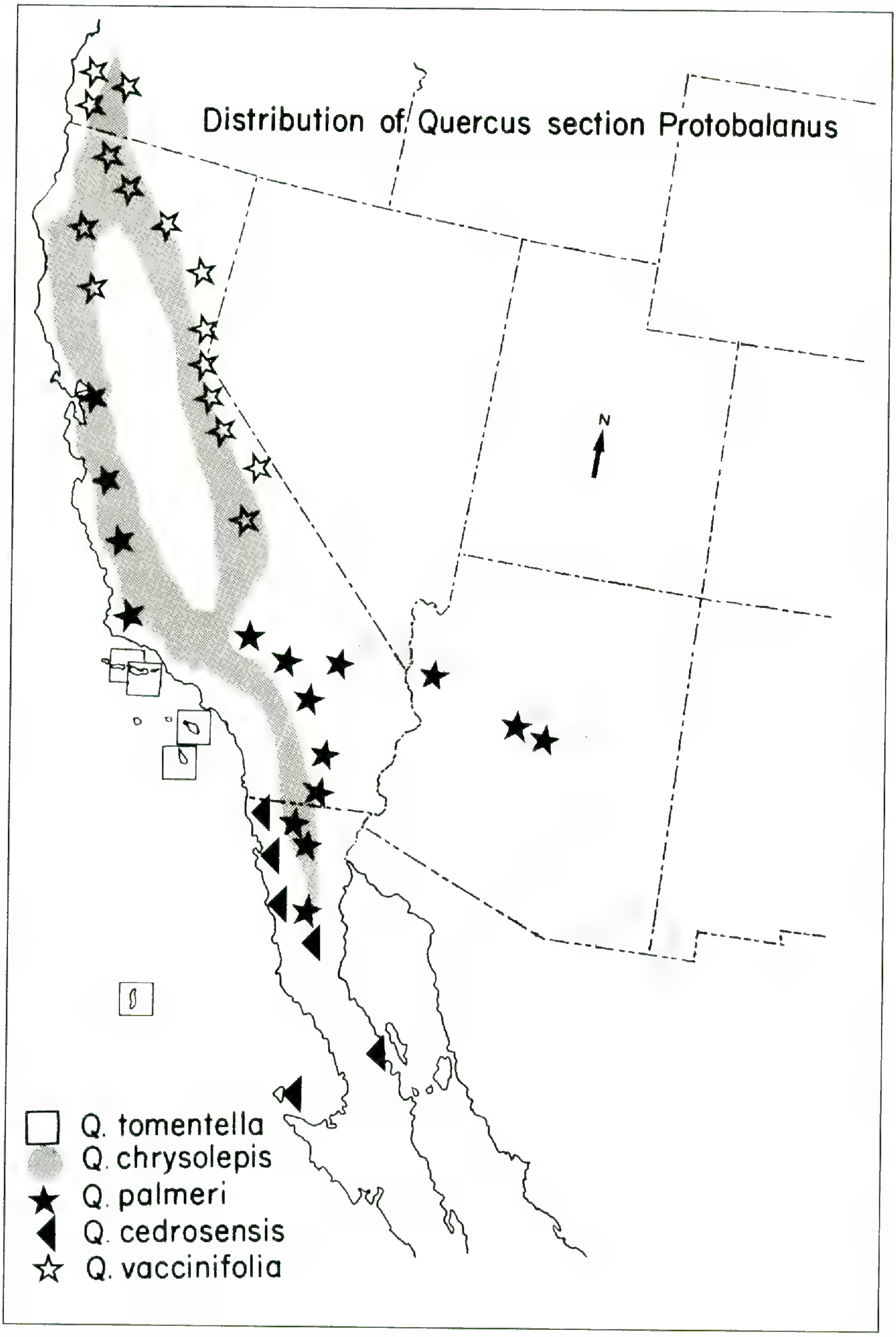

FIG. 1. Approximate distribution of *Quercus* section *Protobalanus*. The range of *Q. chrysolepis* is taken in part from Griffin and Critchfield (1972). The remaining species are mapped according to recent field and herbarium studies (Manos 1992).

The literature on the taxonomic use of trichome characters in *Quercus* ranges from the sectional and species-level to the identification of hybrids. Within certain sections of *Quercus*, trichomes may be of value in circumscribing at least some monophyletic groups. Other groups, however, such as the red oaks of eastern North America, show limited trichome diversity, and the delimitation of subgroups using trichomes alone is difficult (Hardin 1979a). Trichome type is a diagnostic character for a few putatively monophyletic species groups within the white oaks (section *Quercus*). The fused-stellate type found in all species of the "southern live oaks" (subsection *Virentes*) of the white oak group is one example.

Trichome characters have been used the most at the species level in the white oak group, and numerous examples of species-specific trichome complements have been documented in taxa considered to be closely related (e.g. Hardin 1979a, 1979b; Thomson & Mohlenbrock 1979; Nixon & Steele 1981). The identification of hybrids between white oak species has been addressed with patterns of trichome variation in many studies (e.g. Tucker & Müller 1958; Tucker 1963; Maze 1968; Cottam et al. 1982). These authors documented that hybridization between species can result in additive combinations of the trichomes of each species, in addition to modifications expected in other quantifiable characters.

Hardin (1976, 1979b) classified the trichomes of a fairly large sample of red and white oaks as 10 different types based primarily on glandularity, attachment, and ray morphology. Jones (1986), in his comprehensive treatment of foliar features of Fagaceae, discussed the distribution of trichome types found within the major groups of *Quercus* and recognized several more trichome types.

Quercus section *Protobalanus* (Trel.) A. Camus (golden-cup oaks or intermediate oaks), the smallest section of the three recognized within *Quercus* subgenus *Quercus* (Nixon in press), is restricted to western North America and consists of five species of shrubs and small to medium sized trees (Fig. 1). In previous descriptions of the morphology of the species of section *Protobalanus* (Engelmann 1876–1877, 1880; Trelease 1924; Müller 1962), trichomes were described superficially. These taxonomic treatments merely mention the relative density of leaf trichomes and no attempt was made to delimit species with trichomes. Jones (1986) recognized only three non-glandular types in section *Protobalanus*. According to his treatment, section *Protobalanus* has the least diverse complement of non-glandular trichome types of all sections of the genus.

My preliminary observations of herbarium, field collected, and greenhouse grown material of section *Protobalanus* have shown that LM is sufficient to discriminate the trichomes of the recognized species of section *Protobalanus*. Scanning electron microscopy, however, is very useful for illustrative purposes and to determine some fine detail not apparent with LM. These potential characters have not been quantified or described in any previous systematic studies of the group. The purpose of this study is to establish the extent of foliar

TABLE 1. Range and mean for quantitative features of trichomes types found in species of *Quercus* section

Protobalanus.

Species	Ray length (mm) Range	Mean	Number of Rays Range	Mean
Q. cedrosensis				
appressed-fasciculate	0.10–0.15	0.13	2–4	2.5
Q. palmeri				
fasciculate	0.18–0.25	0.20	5–12	8.3
Q. tomentella				
stellate	0.20–0.35	0.29	6–10	8.7
multiradiate & fasciculate	0.37–0.60	0.52	3–10	7.2
Q. chrysolepis				
multiradiate	0.07–0.23	0.11	5–12	8.1
Q. vaccinifolia				
stellate & multiradiate	0.03–0.12	0.06	4–15	7.5

trichome diversity within section *Protobalanus* and to provide additional characters for species identification.

MATERIALS AND METHODS

The majority of specimens used in this study were obtained during several field trips to areas throughout the geographic range of section *Protobalanus* (Fig. 1). These collections represent population samples, most of which were used in other studies of morphological and molecular variation in section *Protobalanus* (Manos 1992). Additional herbarium material was examined at the following herbaria: ASC, DAV, SDM, UCSB, UCR, and SBBG. The Cornelius H. Müller Oak Herbarium (BH-CHM) was a rich source of material of section *Protobalanus*. The personal oak collection of Kevin C. Nixon, soon to be incorporated into BH, provided additional material for study.

Studies of trichome variation were conducted on individuals throughout the range of each species. A light microscope (40× and 200× magnifications) was used to determine trichome type and make observations for eventual calculations of range in ray length, mean ray length, range of ray number, and mean number of rays. These were calculated from 10 representative trichomes per individual examined (Table 1). Ray length was measured from the point of divergence of the ray and base of the trichome. Because samples were not random, standard deviations and confidence intervals were not calculated from these observations.

Following the initial survey of trichomes outlined above, specimens exhibiting typical species-specific trichomes were prepared for examination with SEM. This material was taken from herbarium specimens and dried, greenhouse-grown individuals and mounted onto aluminum stubs and sputter-coated with gold-

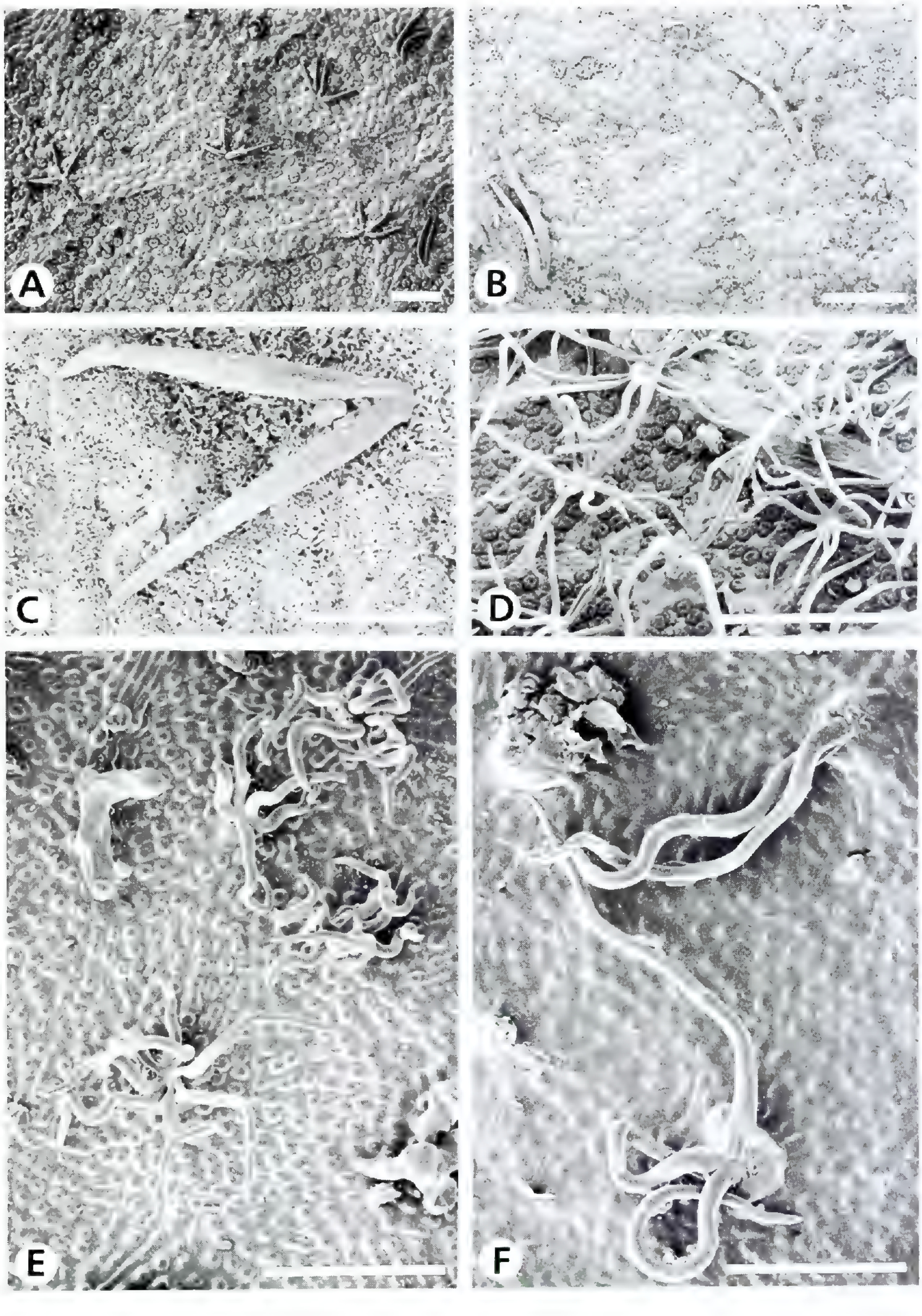

FIG. 2. SEM photographs. A) Appressed-fasciculate, *Q. cedrosensis*, scale bar = 100 μm; B) appressed-fasciculate, *Q. cedrosensis*, scale bar = 100 μm; C) appressed-fasciculate, *Q. cedrosensis*, scale bar = 50 μm; D) fasciculate and stellate, *Q. tomentella*, scale bar = 300 μm; E) fasciculate, *Q. palmeri*, scale bar = 200 μm; F) fasciculate, *Q. palmeri*, scale bar = 100 μm.

palladium for 4 minutes in a Balzer's Union Sputtering Device. All leaf material was prepared without prior treatment or critical point drying. Trichomes pictured with SEM using the simple procedure outlined here do not deviate from typical trichome habit and morphology as observed with LM. An AMR 1000A SEM was used.

RESULTS

The descriptions which follow are representative of the mature condition of adaxial and abaxial leaf surfaces since mature leaves are most often collected for purposes of identification.

The currently recognized species within section *Protobalanus* (*Q. cedrosensis* C.H. Müll., *Q. chrysolepis* Liebm., *Q. palmeri* Engelm. [*Q. dunnii* Kell.], *Q. tomentella* Engelm., and *Q. vaccinifolia* Kell.) were distinguished by non-glandular, thick-walled trichome types. The distinction between *Q. chrysolepis* and *Q. vaccinifolia* was the weakest and based on observations that trichomes of *Q. vaccinifolia* predominantly are stellate, whereas trichomes of *Q. chrysolepis* exclusively are multiradiate. The trichome types found in both species were otherwise clearly differentiable from those seen in *Q. cedrosensis*, *Q. tomentella*, and *Q. palmeri* with both LM and SEM.

The non-glandular trichome complements on both adaxial and abaxial leaf surfaces within species of section *Protobalanus* were similar, and typically only differed in density. One exception is noteworthy. The trichomes of the abaxial surface (Fig. 2 H) of *Q. vaccinifolia* have fewer rays than those of the adaxial surface (Fig. 2 G). Table 1 lists, by species, the type(s) of trichome and includes descriptions of their respective morphology.

The golden glandular trichomes ("branched uniseriate" sensu Jones 1986; "simple branched" sensu Hardin 1976) commonly seen on the abaxial leaf surface, twigs and cupules of *Q. chrysolepis* and *Q. palmeri* are thin-walled and often collapse after drying (Fig. 2 F). Their absence in *Q. cedrosensis* and *Q. vaccinifolia*, combined with other characters, is taxonomically useful to discriminate each from *Q. chrysolepis*. The long solitary trichomes (Hardin 1976) also were observed on some specimens of all species; they are not taxonomically informative.

Descriptions of foliar trichomes of each species

Quercus cedrosensis C.H. Müll.

adaxial: leaf glabrous to puberulent; Types: appressed-fasciculate; no glandular trichomes.
abaxial (Figs. 2 A–C): leaf puberulent with epicuticular wax; Types: appressed-fasciculate and solitary; no glandular trichomes.

Appressed-fasciculate trichomes, persistent on the abaxial surface were diagnostic. This type clearly differs from the appressed-lateral type described by Hardin (1976). Appressed-fasciculate trichomes have not been reported in

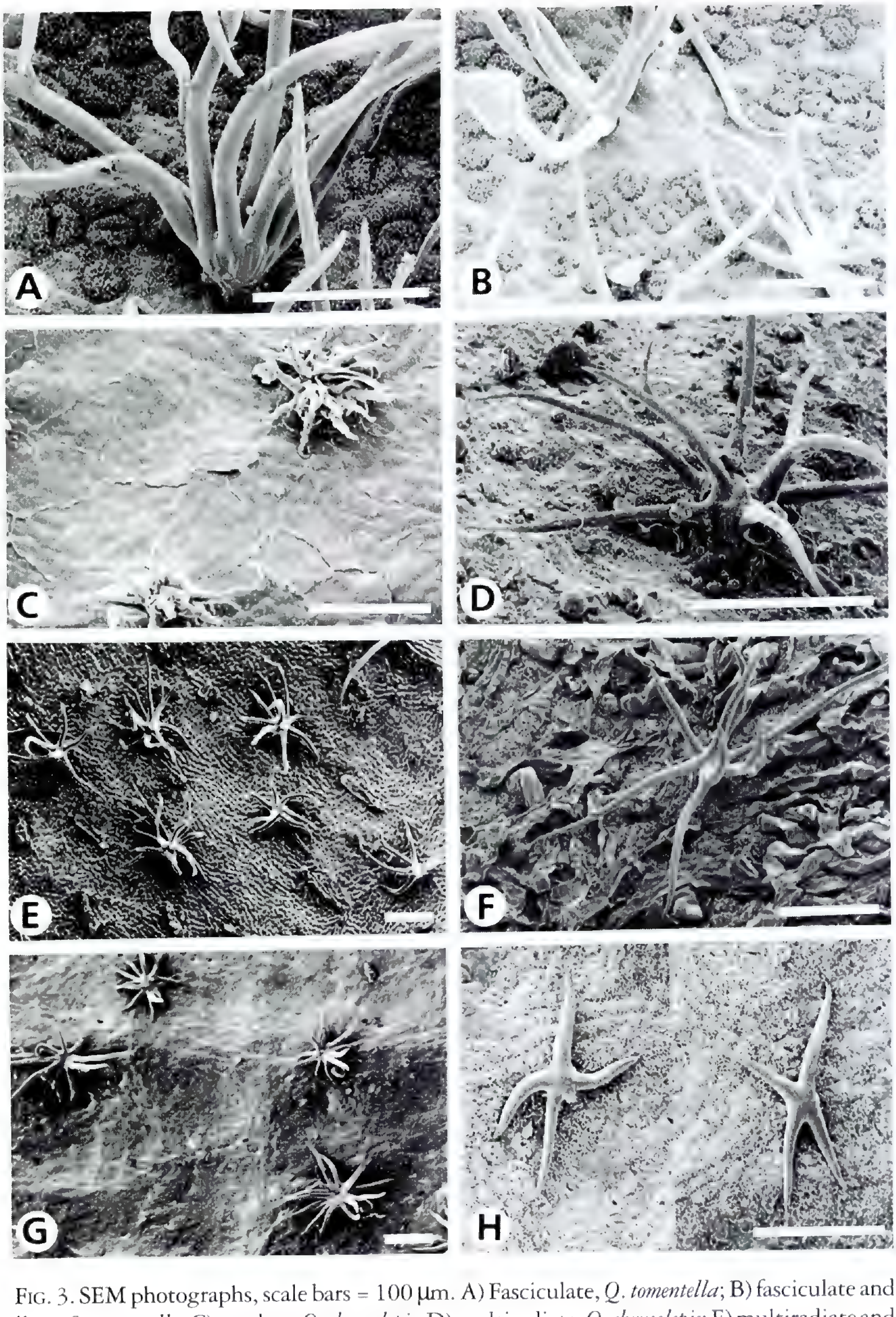

FIG. 3. SEM photographs, scale bars = 100 μm. A) Fasciculate, *Q. tomentella*; B) fasciculate and stellate, *Q. tomentella*; C) rosulate, *Q. chrysolepis*; D) multiradiate, *Q. chrysolepis*; E) multiradiate and simple, *Q. chrysolepis*; F) multiradiate, simple-branched glandular, *Q. chrysolepis*; G) stellate and multiradiate, *Q. vaccinifolia*; H) stellate, *Q. vaccinifolia*.

Quercus. A cellular wall, only visible with LM, was observed between the rays of each 2-rayed unit. These paired trichomes might otherwise appear to represent a single-celled unit.

Quercus palmeri Engelm. [*Q. palmeri* Kell.]

adaxial (Figs. 2 E, F): leaves puberulent; Types: fasciculate, solitary, and glandular.
abaxial: leaves puberulent to tomentose with epicuticular wax; Types: fasciculate and glandular.

Fasciculate trichomes, mostly persistent on the adaxial surface were diagnostic. The rays are erect, splay-out, twist near the apex, and insert on a distinct pedestal formed by the epidermis. Jones (1986) characterized this type as having rays that are joined only at the base.

Quercus tomentella Engelm.

adaxial: leaf sparsely tomentose, mostly near the midrib; Types: fasciculate, multiradiate to stellate, solitary, and glandular.
abaxial (Figs. 2 D; 3 A, B): densely tomentose; Types: fasciculate, multiradiate to stellate, and solitary.

Fasciculate and multiradiate to stellate trichomes with long rays, persistent on the adaxial surface were diagnostic. A weak distinction between the types can made by comparing the longer, erect fasciculate and multiradiate rays with the rays of the stellate type that are shorter and diverge laterally in one plane. The designation of the trichome complement in this species is somewhat arbitrary, because they appear to vary continuously, but this feature alone is diagnostic for *Q. tomentella*. The rays of these types are longer than those observed on the leaves of other species of section *Protobalanus*.

Quercus chrysolepis Liebm.

adaxial (Fig 3 C–E): leaf puberulent; Types: multiradiate, rosulate, simple, and glandular.
abaxial (Fig. 3 F): leaf puberulent to lightly tomentose with epicuticular wax; Types: multiradiate, solitary, and glandular.

Multiradiate and rosulate trichomes, persistent mostly on the adaxial surface, were diagnostic. The multiradiate type was described by Hardin (1976) and Jones (1986) as being composed of approximately 8–12 rays that radiate in more than one plane from a typically rounded common base. The rosulate type also observed in this species seems to represent smaller and especially thin-walled multiradiate trichomes that collapse after drying (Fig. 3 C). They are most common on the adaxial surface of immature leaves that have been dried.

Quercus vaccinifolia Kell.

adaxial (Fig 3 G): leaf glabrous to puberulent; Types: stellate to slightly multiradiate; no glandular trichomes.

abaxial (Fig. 3 H): leaf glabrous to puberulent with epicuticular wax; Types: stellate; no glandular trichomes.

Stellate trichomes were diagnostic, with an occasional upright ray, that approach the multiradiate type seen in *Q. chrysolepis*. The rays are shorter than those of *Q. chrysolepis* and parallel in attachment (Table 1). Stellate trichomes with fewer rays (ca. 4) observed on the abaxial surface also were diagnostic (Fig. 3 H). The ray length of these trichomes was within the range observed for the trichomes of the adaxial surface. The vestiture on the leaves and twigs of this species is often wanting or falls off soon after leaf expansion. On occasion, glandular trichomes were found on individuals collected from lower elevations. This feature is presumably the result of hybridization with *Q. chrysolepis* (Myatt 1975). The 4-rayed stellate trichomes of this species are easily distinguished from those of *Q. cedrosensis*, which often occur as two adjacent pairs of two-rayed trichomes. The rays in *Q. vaccinifolia* always diverged from a common point and are neither laterally-appressed nor composed of 1-rayed or 2-rayed units, as observed in *Q. cedrosensis*.

DISCUSSION

Species delimitation

The non-glandular trichomes of *Quercus* section *Protobalanus* are useful taxonomic characters that consistently delimit previously recognized taxonomic species. Qualitative variation in foliar trichomes provides, in most cases, unambiguous criteria for identifying the species of section *Protobalanus*. However, the distinction between *Q. chrysolepis* and *Q. vaccinifolia* is not based on a constant fixed difference, but rather on a strong trend toward stellate trichomes with shorter rays in *Q. vaccinifolia*. Trichome characters, in conjunction with fixed differences observed in other morphological characters (Manos 1992), can be used to diagnose distinct clusters of populations within section *Protobalanus* that correspond to taxonomic units as defined upon application of a phylogenetic species concept (sensu Nixon and Wheeler 1990).

Intraspecific variation

The majority of within-species trichome variation in *Quercus* is largely in the form of density or persistence (Hardin 1979a; Thomson and Mohlenbrock 1979). Many oak species possess a diagnostic trichome complement; therefore, deviations from a particular complement can be used as an indicator of either hybridization (e.g. Tucker 1963; Hardin 1975) or presence of a cryptic species (e.g. Nixon and Steele 1981).

The trichome complements observed for each species of section *Protobalanus* were relatively uniform in type, although variation in density and ray length, as

well as occasional intergradation between certain types was observed (see *Q. tomentella*). Hardin (1979a) discussed trichome variation in relation to habitat differences and suggested that the oaks of eastern North American showed greater pubescence in drier habitats. Among species of section *Protobalanus*, significant habitat diversity is observed within the ranges of *Q. cedrosensis* and *Q. chrysolepis*.

Multiradiate trichomes were found to be uniformly present throughout the range of *Q. chrysolepis*, with occasional variation in density. At the more mesic locality of Point Reyes, California, the trichomes were more dense than usual and had longer rays accounting for the higher values of ray length within the species, but were otherwise similar to the typical multiradiate type. The trichomes of individuals of *Q. cedrosensis* were identical from habitats on Cedros Island and inland Baja California (ca. 3000 ft) and from more mesic sites on the coast of Baja California (ca. 300 feet). In section *Protobalanus*, greater density of non-glandular trichomes apparently is not correlated with drier habitats. In the case of *Q. chrysolepis*, a few low elevation coastal populations appear to possess a greater density of non-glandular trichomes. The best example demonstrating the correlation of greater density of non-glandular trichomes and mesic habitats in section *Protobalanus* would be *Q. tomentella*, the island oak.

The taxonomic identities of populations from the extremes of the range of section *Protobalanus* are critical to establishing the limits of species boundaries, in addition to the discovery of where these boundaries may break down. One example that Müller (1962) alluded to is the putative *Q. chrysolepis* of the Sierra San Pedro Martir of Baja California, Mexico. These populations have small leaves reminiscent of *Q. cedrosensis*, and small, thin cupules resembling those of Q. *vaccinifolia*. All specimens available from this locality possessed only the typical multiradiate trichomes of *Q. chrysolepis*; therefore, this pattern of morphological variation is best considered intraspecific, and similar to other extreme forms observed in more northern high-elevation populations of *Q. chrysolepis*, rather than the result of past hybridization, as there is no evidence of either a combination of trichome complements or intermediate types.

Hybridization

It has been suggested that hybridization between *Q. chrysolepis* and *Q. palmeri* has occurred in populations of Arizona (Tucker & Haskell 1960; Myatt 1975). In this region, individuals have been variously assigned to *Q. chrysolepis*, *Q. palmeri*, or hybrids, but "pure" *Q. palmeri* is apparently absent based on morphological analysis of vegetative characters (Tucker & Haskell 1960; Manos 1992) and allozyme characters (Manos 1992). Examination of the trichomes present on numerous specimens collected throughout this region also supports the conclusion that "pure" *Q. palmeri* is absent, as only the multiradiate trichomes of *Q. chrysolepis* were observed. Based on other morphological characters (Tucker &

Haskell 1960), a hybrid origin for some of these individuals can not be ruled out; however, repeated backcrossing to *Q. chrysolepis* may have resulted in the loss of an intermediate trichome type or combined complement of types.

Hybridization between *Q. tomentella* and *Q. chrysolepis* has also been invoked to explain the intermediate vegetative features of many individuals on the Channel Islands of San Clemente, Santa Cruz (Manos 1992), and Santa Catalina (Thorne 1967). Examination of the trichomes present on this material supports other morphological evidence, as a novel combination of foliar vestiture was observed on several individuals that seemingly had an intermediate morphology. The following additive combination of trichome complements and densities was observed: 1) adaxial multiradiate trichomes with intermediate ray lengths, 2) abaxial fasciculate and stellate trichomes of *Q. tomentella*, but with shorter rays, 3) an appreciable adaxial cover of glandular trichomes, common in *Q. chrysolepis*, but usually absent on the mature leaves of *Q. tomentella*, 4) a pilose midrib consisting of solitary non-glandular trichomes, common in *Q. tomentella* and absent in *Q. chrysolepis*.

Limitations

An obvious drawback to the use of trichomes in the identification of species of section *Protobalanus* is their deciduous nature. Although many of the mature leaves of species of section *Protobalanus* appear to be devoid of non-glandular trichomes, I have found that a careful examination of first or second year leaves often results in the recovery of some trichomes. The trichomes of *Q. vaccinifolia* are sporadically present, because this species often produces either glabrous leaves or immature leaves that quickly lose their trichomes. This feature alone is often enough to recognize *Q. vaccinifolia*. The combination of stellate trichomes, if available, with other characters of the species is usually reliable evidence for identification of *Q. vaccinifolia*.

Affinities of section *Protobalanus* trichomes

In addition to the taxonomically uninformative solitary trichomes observed on most species of section *Protobalanus*, I have documented four taxonomically useful non-glandular trichome types. This is two more than reported by Jones (1986), who failed to recognize the presence of multiradiate and appressed-fasciculate types within the section, in his summary of the distribution of trichome types within *Quercus*.

Section *Protobalanus* possesses a similar diversity of trichome types when compared to larger groups of *Quercus*. This is somewhat surprising considering its small size and narrow distribution. Jones (1986) stated that trichome complements do not permit recognition of the sections within Quercus; however, his underestimate of the trichome types within *Protobalanus*, a small group, weakens my confidence in his appraisal of the other, more speciose sections and of the genus

as a whole. Because of the great importance of trichomes to oak taxonomy, a review of trichome diversity in *Quercus* and revised classification of trichome types is needed.

Hardin (1979) presented some generalizations concerning patterns of variation in trichomes between eastern North American red (black) and white oaks and their phylogenetic implications. Red oaks tend to have trichomes of the thick-walled multiradiate type and thin-walled rosulate type. The rosulate type appears to represent thin-walled multiradiate trichomes that collapsed upon drying. The predominant types within the white oaks are fasciculate and stellate. This assessment generally holds true for oak species from other regions (Nixon personal communication). While this pattern is relatively constant, certain exceptions are sure to be encountered. As observed here, multiradiate trichomes occur on *Q. chrysolepis*, while the other types observed in the section are commonly present in both red and white oaks. The trichome complement within section *Protobalanus* has a combination of types typically observed in other sections of *Quercus*. Other morphological characters of section *Protobalanus*, such as the frequent lateral position of abortive ovules in mature fruit, also appear intermediate relative to the condition observed in red (apical abortive ovules) and white (basal abortive ovules) oaks. Although a hybrid origin for the section remains a possibility, morphological and molecular investigations have not provided additional evidence in support of this hypothesis (Manos 1992). The apparent intermediate morphology of section *Protobalanus* led Trelease (1924; subg. *Protobalanus*) to hypothesize an ancestral relationship for the section with respect to both red and white oak groups. Recent cladistic analysis of *Quercus* (Nixon 1985, in press), however, supported a sister group relationship for section *Protobalanus* and the white oaks (section *Quercus*, E & W hemisphere), whereas the red oaks occupy a more basal position. According to that phylogenetic analysis, section *Protobalanus* shares ancestral character-states with the red oaks and derived character-states with the more closely related white oaks (section *Quercus*).

ACKNOWLEDGMENTS

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BOOK NOTICES

AVERETT, JOHN E. (ed.) 1991. **Proceedings of the Conference: Landscaping with Wild Flowers and Native Plants**. March 13-15, 1991. (pbk). National Wild Flower Research Center, 2600 FM 973 North, Austin, TX 78725. No price given. 125 pp.

This publication is a special issue of the journal, *Wild Flower* 4:(3). There are 24 papers. A few papers address the use of wild flowers and other native plants in woodland gardens, meadows and also for formal landscape designs. Most of the papers emphasize the ecological benefits of planting indigenous plants.—*Krishna Puttaparthi*

BONTA, M. M. 1991. **Women in the Field.** (ISBN 0-89096-489-0, pbk). Texas A&M University Press, College Station, TX 77843. $13.95. 299 pp.

The accomplishments of the women naturalists (one person per chapter) speak for themselves, but anyone wishing to know about the *lives* of the women will want this volume. To the readers of *Sida*, the most familiar of these "women in the field" will be those in part 3, Botanists: Kate Furbish, Kate Brandegee, Alice Eastwood, Ynes Mexia, Mary Sophia Young, Elizabeth Gertrude Knight Britton, and Agnes Chase. Pioneers, Naturalists, Entomologists, Ornithologists, and Ecologists are covered in the remaining parts. Biographical data on other noteworthy women, including E. Lucy Braun ("... only a small part of her life has been pieced together by reading secondary sources") are found in the introduction to each part. Well and interestingly written, and illustrated with 30 black-and-white photographs of the protagonists and their work, the book is highly recommended.—*John W. Thieret.*

GOODLAND, ROBERT. 1990. **Race to Save the Tropics.** (ISBN 1-55963-040-X, pbk). Island Press, Suite 300, 1718 Connecticut Avenue NW, Washington, DC 20009. No price given. 219 pp.

This book focuses on applied tropical ecology and development issues in tropical countries. It is a compilation of works from some of the world's experts on applied tropical ecology. The contents are Applied Ecology, Agro Ecology, Agricultural Pest Management, Tropical Forest Management, The Role of Applied Ecology in Designing Dams, Teaching Applied Ecology in Developing Countries, and Importance of Applied Ecology in Conservation Strategies in the Tropics. The volume has a bibliography, appendixes, a list of contributors and an index.—*Krishna Puttaparthi.*

THE GENUS *UROCHLOA* (POACEAE: PANICEAE) IN TEXAS, INCLUDING ONE PREVIOUSLY UNREPORTED SPECIES FOR THE STATE

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ABSTRACT

Urochloa is represented in Texas by three species, *U. mosambicensis*, *U. panicoides*, and *U. reptans*. *Urochloa mosambicensis* is being reported new for Texas. *Urochloa panicoides* has recently been reported in the state and is listed in the Federal Noxious Weed Act. *Urochloa reptans* has been recognized in Texas and the U.S. as *Panicum reptans* or, more recently, *Brachiaria reptans*. A key to distinguish related genera, a key to the species of *Urochloa* in Texas, species descriptions, and their distribution in Texas are provided.

RESUMEN

Urochloa está representada en Texas por tres especies, *U. mosambicensis*, *U. panicoides* y *U. reptans*. *Urochloa mosambicensis* se cita como nueva para Texas. *Urochloa panicoides* ha sido citada recientemente en el estado y está catalogada en la Ley Federal de Plantas Nocivas (Federal Noxious Weed Act). *Urochloa reptans* ha sido reconocida en Texas y en el resto de los Estados Unidos como *Panicum reptans*, o más recientemente como *Brachiaria reptans*. Se ofrece una clave para identificar los géneros próximos, otra clave para las especies de *Urochloa* en Texas, así como descripciones de las especies y su distribución en Texas.

Urochloa P. Beauvois is native to the Old World tropics, mainly Africa, and consists of about 12 species (Clayton and Renvoize 1986). *Urochloa* has not previously been treated in any Texas manual (Correll and Johnston 1970, nor

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Gould 1975). It is represented in Texas by three species, *U. mosambicensis* (Hackel) Dandy, *U. panicoides* P. Beauvois, and *U. reptans* (L.) Stapf. *Urochloa mosambicensis*, native to Africa, has recently been collected in Texas and is new for the state. All previous collections of this species from Texas were those from cultivated plots. *Urochloa panicoides*, native to Africa and India, has been reported from New Mexico (Hatch 1977), Mexico (McVaugh 1983) and recently from Texas (Hatch et al. 1990). This taxon is listed in the Federal Noxious Weed Act [7 CFR Part 360.200 (C)]. *Urochloa reptans*, native to tropical Asia, has been traditionally recognized by American authors in *Panicum* (Chase 1951, and Correll and Johnston 1970) or *Brachiaria* (Gould 1975). It has been reported from Florida to Texas (Chase 1951), Mexico (McVaugh 1983), south to Central America, Costa Rica (Pohl 1980), and northern South America (Judziewicz 1990).

Urochloa and *Brachiaria* are closely related genera. *Urochloa* has an inflorescence that is a panicle of unilateral primary branches, spikelets in which the first glume is facing away from the primary branch (Fig. 1D), and usually has a mucronate to awn tipped upper lemma (Fig. 2C). *Brachiaria* also has an inflorescence that is a panicle of unilateral primary branches, but in some taxa there can be some rebranching of the primary branches. The spikelets are oriented so that the first glume is facing towards the primary branch (Fig. 1C) and the upper lemma is usually awnless, but occasionally mucronate. Traditionally these two genera are separated by the orientation of the spikelets. Using this criteria to delimit the genera, *Panicum reptans* L. is recognized in *Urochloa*, and not in *Panicum* nor *Brachiaria*. Spikelet orientation can be difficult to determine, especially if the spikelets are on long pedicels. Gardner and Hubbard (1938) suggested examining the spikelet just below the terminal one on a primary branch. This spikelet is generally short-pedicellate and appressed to the primary branch. Spikelet orientation is easily determined when the branches are in the sheath or just after exsertion.

Since, *Urochloa* has not previously been treated in a Texas manual, a key is needed to distinguish it from other related genera of the Paniceae tribe. A key to the genera of Paniceae with unbranched primary branches is provided. Sometimes there can be some rebranching at the base of the primary branch.

KEY TO THE GENERA OF TEXAS PANICEAE WITH PANICLES OF UNBRANCHED PRIMARY BRANCHES

1.	Glumes awned	2
1.	Glumes awnless or absent	3
2(1).	First glume as long as second glume (excluding awns), first glume awn longer than the second glume awn; ligule a ciliate membrane	*Oplismenus*
2.	First glume shorter than second glume (excluding awns), first glume awnless or short awned; ligule absent or a stiff ring of hairs	*Echinochloa*
3(1).	First glume reduced to a cup-like or disc-like ring (Fig. 1-A) present at the base of the spikelet (pedicel resembling a golf tee)	*Eriochloa*
3.	First glume present or absent, if present, not forming a cup-like structure at the base of the spikelet	4

4(3). Lemma margins of upper floret membranous, white, flat, and not inrolling over the palea ..... *Digitaria*
4. Lemma margins of upper floret firm, not membranous, the same texture as back of lemma and margins inrolled over the palea 5
5(4). First glumes absent 6
5. First glumes present 7
6(5). Second glume facing away from primary branch (Fig. 1-C); primary branch three angled ..... *Axonopus*
6. Second glume facing towards (lying against) primary branch (Fig. 1-D); the primary branch not three-angled, but flattened ..... *Paspalum*
7(5). Lemma of upper floret smooth and shiny 8
7. Lemma of upper floret roughened, usually transversely roughened, not smooth; dull or shiny 14
8(7). Ligule absent ..... *Echinochloa*
8. Ligule present 9
9(8). Spikelets awned ..... *Echinochloa*
9. Spikelets awnless 10
10(9). Primary branch extends past the terminal spikelet as a point or bristle (rarely with a reduced spikelet on the point or bristle) ..... *Paspalidium*
10. Primary branch not extending past the terminal spikelet as a point or bristle 11
11(10). First glume not present on all spikelets ..... *Paspalum*
11. First glume present on all spikelets 12
12(11). First glumes consistently 1/2 to as long as the spikelet ..... *Panicum*
12. First glumes consistently less than 1/2 as long as the spikelet or variable in length, some are less than 1/2, and some are more than 1/2 as long as the spikelet 13
13(12). First glume conspicuously 3–5 veined and distinctly clasping the spikelet; palea, of upper floret, apex narrowly acute ..... *Panicum*
13. First glume 0–1 veined and not clasping the spikelet; palea, of upper floret, apex blunt to rounded ..... *Paspalum*
14(7). First glume facing towards the primary branch (Fig. 1-C) ..... *Brachiaria*
14. First glume facing away from the primary branch (Fig. 1-D) 15
15(14). Primary branch extends past the terminal spikelet as a point or bristle (rarely with a reduced spikelet on the point or bristle) ..... *Paspalidium*
15. Primary branch not extending past the terminal spikelet as a point or bristle 16
16(15). Lemma of uppermost floret with a mucronate or awned apex; plants annual or perennial ..... *Urochloa*
16. Lemma of uppermost floret awnless, apex acute to rounded; plants perennial ..... *Paspalum*

KEY TO THE TEXAS SPECIES OF *UROCHLOA*

1. Spikelets 1.8–2.2 mm long ..... ***U. reptans***
1. Spikelets 2.5–5.5 mm 2
2(1). First glume more than 2/3 (rarely 1/2) as long as spikelet; 1–3 conspicuous trichomes on the upper 1/2 of the first glume; first glume 3-veined; perennial ..... ***U. mosambicensis***
2. First glume up to 1/2 as long as spikelet; without conspicuous trichomes on first glume; first glume 3–5 veined; annual ..... ***U. panicoides***

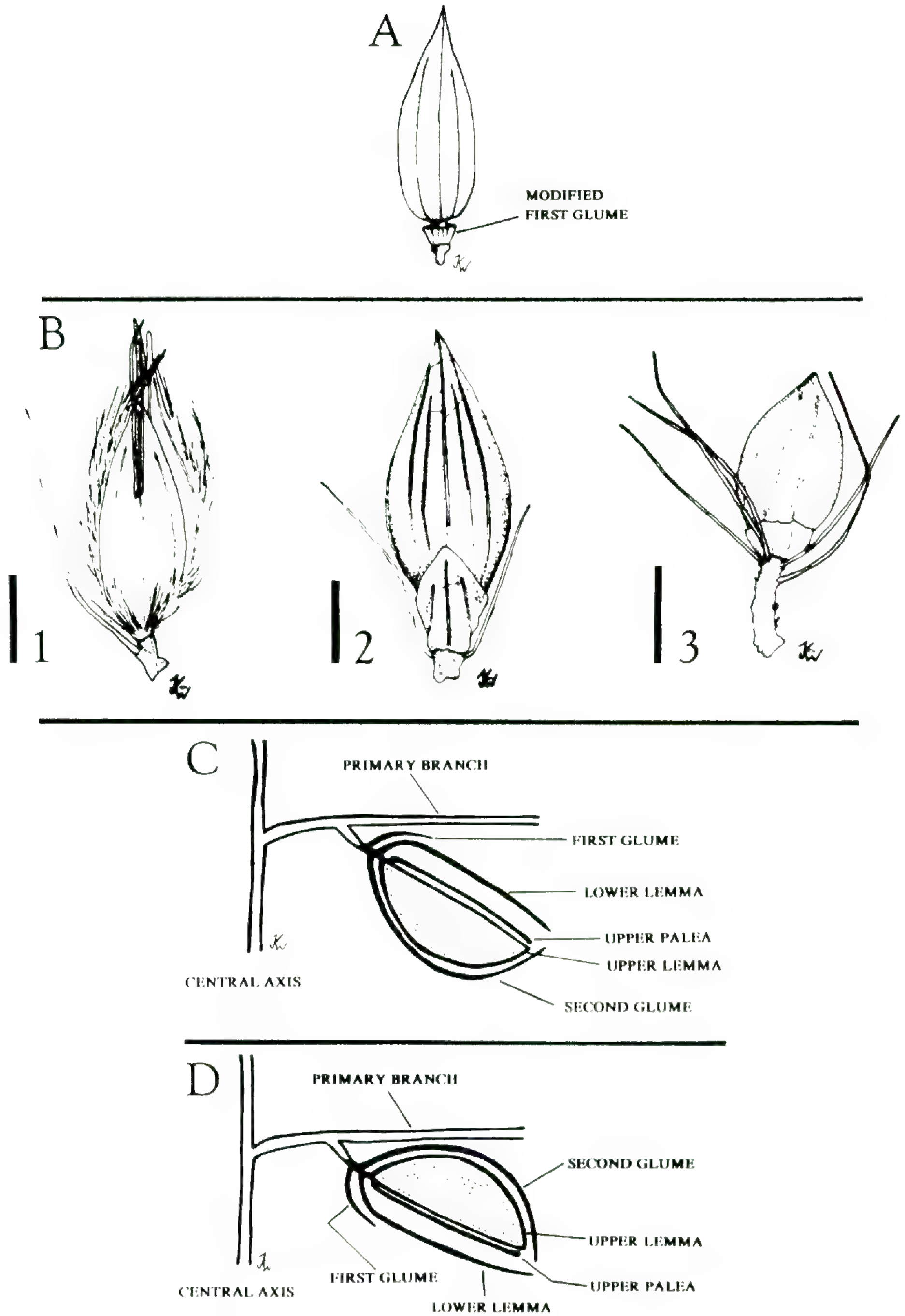

FIG. 1. (A): Illustration of an *Eriochloa* spikelet showing the modified first glume; (B): Spikelets of the three *Urochloa* species in Texas, showing the first glume. Bar equals 1 mm.: (1) *U. mosambicensis* spikelet; (2) *U. panicoides* spikelet; (3) *U. reptans* spikelet. (C): Diagrammatic illustration of the spikelet orientation on the primary branch. The second glume is facing away from the branch and the first glume is lying against the branch. (D): Diagrammatic illustration of the spikelet orientation on the primary branch. The second glume is lying against the branch and the first glume is facing away from the branch.

Urochloa mosambicensis (Hackel) Dandy, J. Bot. Brit. & For. 69:54. 1931. (Fig. 1-B1). TYPE: AFRICA. **Mozambique**, *de Carvalho* (ISOTYPE: K [Clayton and Renvoize 1982]). *Panicum mosambicense* Hackel, Bol. Soc. Brot. 6:140. 1888.

Urochloa pullulans Stapf, Flora of Tropical Africa 9:590. 1920. *nom. superfl.*, based on *Panicum mosambicense*.

Urochloa rhodesiensis Stent, Proc. Trans. Rhod. Sci. Ass. 32:26. 1933. TYPES: AFRICA. **Zimbabwe:** Nyamandhlovu, *Rattray 500 & Salisbury* (ISOSYNTYPE: K), *Stent* in S.R.G.H. *3669* (ISOSYNTYPE: K), *Stent 4516* (SYNTYPE: SRGH) and *Stent 5547* (ISOSYNTYPE: K) (Clayton and Renvoize 1982).

Perennial, cespitose or stoloniferous, usually rooting at the lower nodes. *Culms* 20–150 cm long; pubescent with papilla-based trichomes; nodes pubescent. *Leaves* cauline; *sheaths* shorter than internodes, basal sheaths silky pubescent, upper sheaths pubescent with papilla-based trichomes; *ligules* 1.0–2.0 mm long, a ciliate membrane; *blades* (1.3) 3.0–8.5 (30) cm long, (1.5) 3.0–7.0 (20) mm wide, flat, pubescent with scattered papilla-based trichomes; margins cartilaginous and antrorsely scaberulous. *Inflorescence* (3) 6.5–9.5 (12.5) cm long, a panicle of (2) 3–6 (15) spicate primary unilateral branches, central axis pubescent; *branches* (2) 3.0–6.0 (8) cm long, margins antrorsely scaberulous, 1 per node; branches ascending, appressed to central axis; branches terminated by spikelet. *Pedicels* 0.2–0.5 mm long, with 1–3 conspicuous trichomes to 5 mm long. *Spikelets* (3.0) 4.0–4.7 (5.0) mm long, oriented with the first glume away from the branch axis (Fig. 1-D), a tuft of trichomes at base of spikelet; *first glume* 2.8–3.3 mm long, (1/2) 2/3–3/4 the length of the spikelet, 3-veined, glabrous except for 1–3 conspicuous trichomes, 1.5–2.7 mm long, originating on or near the mid-vein in the upper 1/2 of the glume, apex erose, margins frequently purple tinged and antrorsely ciliolate; *second glume* (3.0) 4.0–4.7 (5.0) mm long, as long as the spikelet, 5-veined, pubescent, apex narrowly acuminate to an awn-like tip. *Lower floret* staminate; anthers 1.9–2.2 mm long, yellow; *lemma of lower (sterile) floret* 3.0–4.0 mm long, 5-veined, lateral veins adjacent to one another, sparsely pubescent on back, margins conspicuously pubescent in mid-section of lemma with long appressed trichomes to 2.1 mm long, trichomes white to purple tinged, apex narrowly acuminate to an awn-like tip; *palea* 3.0–3.5 mm long, membranous, apex cuspidate to narrowly acuminate; *lemma of upper (fertile) floret* 2.2–2.6 mm long, transversely rugose, apex rounded, awn-tipped; awn 0.5–0.7 (1.2) mm long, awn antrorsely puberlent; *palea* 2.1–2.3 mm long, apex rounded, longitudinally roughened. *Anthers* 1.4–1.5 mm long, yellow, 3 stamen.

Specimen Examined. TEXAS. **Jim Wells Co.:** 7C Ranch off county rd. 418. 26 Sep 1992, *Canales 9* (TAES). Associated species: *Bothriochloa barbinodis* (Lag.) Herter, *Hilaria belangeri* (Steud.) Nash, *Setaria macrostachya* Kunth in H.B.K., *Eragrostis secundiflora* Presl subsp. *oxylepis* (Torrey) S.D. Koch, *Pennisetum ciliare* (L.) Link var. *ciliare*, and *Chloris cucullata* Bischoff.

Urochloa panicoides P. Beauvois, Ess. Agrost. 53, fig. 11(1). 1812. (Figs. 1-B2 and 2). TYPE: **Mauritius**, *de. Jussieu* (whereabouts uncertain [Clayton and Renvoise, 1982]).

FIG. 2. Illustration of *Urochloa panicoides* P. Beauv.; bar equals 4 cm. (Drawn from: *Wipff 2027, S. & G. Jones* [TAES]).

LIVERSEED GRASS. Annual with ascending to prostrate-decumbent culms, usually rooting at lower nodes. *Culms* 5–90 cm long; glabrous to sparsely pubescent; nodes usually pubescent. *Leaves* cauline; *sheaths* 1/2 the length of the

internodes; pubescent, margins usually conspicuously pubescent, at least on one side; *ligules* 1–1.5 mm long, a ring of trichomes; *blades* (2) 5–10 (25) cm long, 5–14 (18) mm wide, flat, pubescent, with scattered papillose trichomes; margins undulate, with papilla based trichomes. *Inflorescence* 5–10 cm long, a panicle of 2–7 (10) spicate primary unilateral branches; *branches* (1) 2.5–6.0 (7) cm long, antrorsely scabrous, 1 (2) per node, lowermost branch spreading, uppermost branch ascending, terminated by spikelet. *Pedicels* 0.3–0.5 mm long, with 1–3 (5) trichomes to 5 mm long. *Spikelets* (2.5) 3.5–4.5 (5.5) mm long, oriented with the first glume away from the branch axis (Fig. 1-D); *first glume* 1.3–1.6 mm long, 3–5-veined, broadly triangular, approximately 1/4 the length of the second glume; *second glume* 3.8–4.3 (5.0) mm long, 9–11 (–13)-veined, ovate, glabrous; *lower floret* neuter; *lemma of lower (sterile) floret* 3.8–4.2 (5) mm long, 5–(–7)-veined, ovate, apex acute; *palea* nearly as long as lemma; *lemma of upper (fertile) floret* 2.8–3.5 mm long, transversely rugose, apex rounded, awn-tipped; awn (0.3) 0.6–1.0 mm long; *palea* nearly as long as lemma, apex rounded. *Anthers* 0.8–1.0 mm long, yellow, 3 stamen; *caryopsis* 2.0–2.5 mm long, ovate. *Flowering Period:* June-November (January). Adventive in lawns, playgrounds, along railroad tracks and roadsides, and other disturbed sites.

Specimens Examined. TEXAS. **Calhoun Co.:** 1.9 mi NE on TX Hwy 35 from its jct with the Guadalupe River (NE of Tivoli); open, disturbed roadside, 17 Oct 1991, *Wipff 2125 & S. & G. Jones* (TAES). **Cameron Co.:** 10 mi W of Port Isabel on Hwy 100, roadside near a culvert, 14 Oct 1984, *Lonard 5001* (PAUH, TAES). **Hidalgo Co.:** weedy lawn near a tennis court on the Edinburg High School campus, Edinburg, 12 Aug 1972, *Lonard 3109* (PAUH, TAES); weedy playground at Jefferson Elementary School, Edinburg, clay loam, 15 Sept 1984, *Lonard 4931.* **Jim Wells Co.:** ca. 150 m S on County Rd 339 (extension of FR 2044) from its jct with TX 44, SW of Agua Dulce, disturbed roadside between the ditch and adjacent mesquite thicket, 01 Jul 1992, *S. & G. Jones 9092* (BRIT/SMU, PAUH, TAES). **Kleberg Co.:** NW corner of US 77 and Caesar Ave., SE side of Kingsville, 14 Jan 1992, *S. & G. Jones 7871* (BRIT/SMU, PAUH, TAES). **Maverick Co.:** 100 m W on Hwy 277 from its jct with FR 1665 (E of Quemado); W side of Quemado Creek, open disturbed roadside, 15 Jun 1991, *Wipff 2027 & S. & G. Jones* (TAES). **Nueces Co.:** 100–150 m W on FR 70 from its jct with County Rd 63A (E of Bishop and S of Petronila), open disturbed roadside, 17 Oct 1991, *Wipff 2132 & S. & G. Jones* (TAES). **Refugio Co.:** SE side of Guadalupe River on TX Hwy 35 (NE of Tivoli), 100–200 m from Guadalupe River on SE side of Hwy, open disturbed roadside, 17 Oct 1991, *Wipff 2128 & S. & G. Jones* (TAES). **San Patricio Co.:** at the jct of US 77 (Voss St.) and the spur of the Southern Pacific and Missouri railroad, just SW of Humphries Street in Odem, 14 Jan 1992, *S. & G. Jones 7872* (PAUH, SAT, SWT, TAES).

A survey for *U. panicoides* was conducted by Larry Fowler, Ruben Garcia, and Darell Belcher from the USDA-APHIS-PPQ, during the period from 20 August to 16 September 1991, which resulted in the location of this species in Cameron, Hidalgo, Willacy, and Zapata Counties. Larry Fowler (pers. comm.) also reported a collection from Starr County.

Urochloa reptans (L.) Stapf, Flora of Tropical Africa 9:601. 1920. (Fig. 1-B3).
TYPE: **Jamaica**, *Browne* (HOLOTYPE: LINN, Clayton and Renvoize 1982). *Panicum reptans* L.,

Syst. Nat. ed. 10, 2:870. 1759. *Brachiaria reptans* (L.) Gardner & C.E. Hubbard in Hook, Ic. Pl. 34, t.3363. 1938.

Annual, mat forming, rooting at the nodes. *Culms* 10–35 cm tall, prostrate, upper culms becoming erect, branching extensively, glabrous; nodes glabrous to sparsely pubescent; *leaves* cauline. *Sheaths* keeled, as long as the internodes, glabrous, margins densely pubescent. *Ligules* a ring of trichomes, to 1.5 mm long. *Blades* 2.0–5.5 cm long, 5–10 mm wide, flat, usually undulate margins, midrib indistinct, glabrous above with a few scattered trichomes below, margins antrorsely scabrous with regularly spaced papilla based trichomes. *Inflorescence* 1.5–6 cm long, 4–5 cm wide, a panicle with unilateral primary branches; primary branches unbranched, occasionally rebranched at base of branches; *branches* 1.0–4.0 cm long, 4–10(16) branches, ascending to spreading, 1–2 per node; spikelets single or paired, if paired, one of the pair on a longer pedicel, *pedicels* 0.1–1.3 mm long, with 3–5 scattered trichomes. *Spikelets* 1.8–2.2 mm long, ovate, oriented with the first glume away from the branch axis (Fig. 1-D); *first glume* 0.2–0.5 mm long, 0–3 veined; *second glume* 1.8–2.0 mm long, 7-veined, glabrous; *lower floret* neuter or staminate; *lemma of lower (sterile) floret* 1.7–2.0 mm long, 5-veined, glabrous; *palea* 1.5–1.8 mm long, membranous; *lemma of upper (fertile) floret* 1.5–1.7 mm long, indistinctly veined, rugose, glabrous, apex rounded and mucronate, mucro 0.1 mm long; *palea* 1.5–1.6 mm long, rugose. *Anthers* (0.5) 0.6–1.1 mm long, stamens 3; *caryopsis* 0.8–1.2 mm long. *Flowering Period:* mainly August through October, but known to flower as early as May. *Distribution*: Region 1 (Pineywoods), region 2 (Gulf Prairies and Marshes), and region 6 (South Texas Plains) as defined by Hatch et al. (1990). Along roadside and on other disturbed sites.

ACKNOWLEDGMENTS

We would like to thank Larry Fowler (USDA-APHIS-PPQ, Brownsville) for his review and assistance on this manuscript, and Keith Westover for the illustration of the plant habit of *Urochloa panicoides*. The other illustrations were drawn by the senior author. This is Technical Bulletin TA-30814, Texas Agricultural Experiment Station.

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BOOK NOTICES

HARDIN, J. H. 1992. **Foliar Morphology of the Common Trees of North Carolina and Adjacent States.** (pbk). North Carolina Agricultural Research Service Technical Bulletin 298. Department of Agricultural Communications, Box 7603, North Carolina State University, Raleigh, NC 27695. $10.00. 135 pp.

This work provides descriptions of macro- and micro-morphology of the leaves of North Carolina trees. Micro-morphological features include cellular relief, cuticular patterns, presence or absence and form of epicuticular wax, and trichome structure, form, and orientation. Line drawings of whole leaves, showing vein patterns (but not stipules); one to three splendid SEM photographs of abaxial and adaxial leaf surfaces; and descriptions of both morphologies are given for each of the 155 varieties or species included. Three pages are devoted to a discussion of morphology and a definition of terms; and two pages, to Literature Cited (52 references).—*John W. Thieret.*

HATCH, S. L. and J. PLUHAR. 1993. **Texas Range Plants.** (ISBN 89096-521-8, pbk; 0-89096-538-2, hbk). Texas A&M University Press, College Station, TX 77843. $14.95 (pbk), $35.00 (hbk). 326 pp.

This book was written to aid in identification of 140 Texas range forbs, shrubs, and trees important as forage, poisonous plants, or weeds. A detailed, full-page description and, facing it, a full-page line drawing are given for each species. The introduction discusses range plants (taxonomy, longevity, origin, economic value) and grass morphology (about half of the book is devoted to Poaceae) and gives 20 pages of illustrations to elucidate terminology. A glossary occupies 10 pages and is followed by 70 selected references and a detailed index.—*John W. Thieret.*

HOFFMANN, DAVID. 1991. **The New Holistic Herbal.** (ISBN 1-85230-193-7, pbk). Element Inc., 42 Broadway, Rockport, MA 01966. $16.95. 284 pp.

This is an interesting and fascinating book on herbal medicine. The book consists of three parts. The first part talks about plants and their relationship with humanity. The second part discusses herbs and the herbal treatment of the systems of the body. The last part describes the herbs in detail and gives information about their chemistry and actions. The book has list of suppliers, bibliography, index of English names and an index of botanical names. Anyone interested in herbal medicine will appreciate this book.—*Krishna Puttaparthi.*

A NEW SPECIES OF *HEDEOMA* (LAMIACEAE) FROM NORTHEASTERN MEXICO

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ABSTRACT

Hedeoma oblatifolia Villarreal sp. nov., from the mountains of southeastern Coahuila (Northeast Mexico), is described and illustrated. It is similar to *H. johnstonii* Irving, and is easily recognized by its relatively larger flower, circular-oblate leaves and retrorse hairs on the stem.

RESUMEN

Hedeoma oblatifolia Villarreal sp. nov. de las montañas del sureste de coahuila (Noreste de México), es descrita e ilustrada. Es similar a *H. johnstonii* Irving, y se reconoce facilmente por sus flores relativamente grandes, hojas circular-obladas y pelos retrorsos en el tallo.

KEY WORDS: Lamiaceae, *Hedeoma*, Coahuila, Flora of México.

Hedeoma, which is primarily a Mexican/North American genus, was revised by Irving (1980). Subsequently, Henrickson (1986) and Turner (1991) have contributed to the taxonomy of the genus and a brief account of the genus can be found in the recent review of Mexican Lamiaceae by Ramamoorthy and Elliott (1993). The flora of Northeast México is only beginning to be appreciated; it consists of many narrow endemic, especially in the alpine areas of the territory (McDonald 1993). Among novelties that are being discovered in the course of routine study of the flora of this part of Mexico is *Hedeoma oblatifolia* from southeastern Coahuila.

Hedeoma oblatifolia Villarreal sp. nov. (Fig. 1)

Herbae perennes, caules usque ad 30 cm alti trichomatibus retrorsum crispatis bilineatisque. Folia patentia glabra oblata vel orbiculati-oblata, marginibus denticulatis. Cymulae 1–3 flores ferentes. Calyx tubularis 8–10 mm longus. Corolla tubularis ca. 35 mm longa violacea. Nuculae ca. 2 mm longae.

Wiry perennial herb up to 30 cm tall; shoots ascending, numerous, unbranched, rooting at the lower nodes, 4-angled with retrorsely curly hairs in two lines along the stem, changing in position alternately at each internode. Leaves spreading, lightly coriaceous in texture, glabrous, glandular punctate sparsely in the lower surface, oblate-circular 6–14 mm long, 8–15 mm wide with 4–8 pairs of diminutive teeth along the margin; petiole short 1–2 mm long, midrib and secondaries elevated on the lower surface. Flowers in cymules of 1–3 peduncles

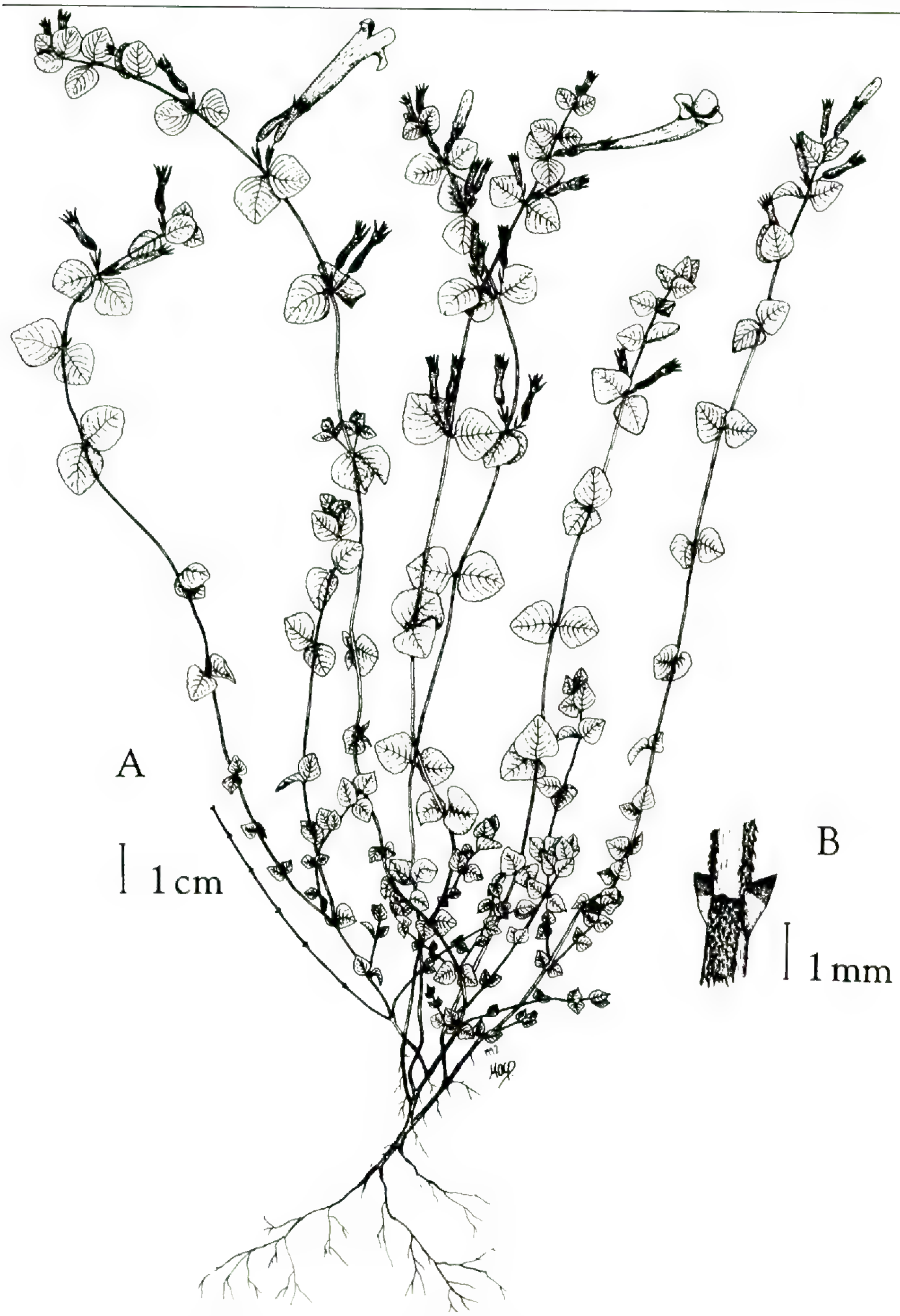

FIG. 1. *Hedeoma oblatifolia*. A. Habit, B. Internode showing retrorse hairs, 12×.

4 mm long, pedicels 5–6 mm long, both with short retrorse curly hairs; bracteoles lanceolate, glabrous, equal or slightly longer than the pedicels. Calyx tubular, slightly gibbous, 8–10 mm long, sparsely hirsute; upper teeth partially united

forming a slightly reflexed lip, lobes triangular 2 mm long, hirsute-ciliate; lower teeth 3–4 mm long, elongated at the tip, hirsute-ciliate, annulus at the end of the tube. Corolla tubular or slightly widened to the mouth, up to 35 mm long, showy, violet, the upper lip short 4–5 mm long, the lower lip 7–8 mm long, trilobate. Fertile stamens 2, ascending under the upper lip, anthers divaricate, staminods reduced to short filaments. Style glabrous, unequally forked at the apex. Nutlets oblong, 2 mm long, black.

TYPE: MEXICO. **Coahuila**. Mpio. Saltillo, Sierra Catana, 40 km SW de Saltillo, 101° 12' W, 25° 15' N, paredes rocosas en bosque de *Quercus hypoxantha* y *Pseudotsuga menziesii* con *Cercocarpus macrophyllus*, 2900–3100 m. 29 Jul 1992, *J.A. Villarreal Q. 6466, M.A. Carranza y H. Nieto* (HOLOTYPE: MEXU; ISOTYPES: ANSM, ENCB, TEX.).

Distribution: Presently know only from the type locality.

The population of *Hedeoma oblatifolia* was found on rocky slopes at higher elevations (2900 to 3100 m) in a mesic forest of oaks and Douglas Fir. Among the interesting species found in this areas are *Chrysactinia truncata, Brachypodium mexicanum* and *Galium uncinulatum*. Its restricted distribution along with the many other endemic species of *Hedeoma*, regards northeastern México as a center of diversity for the genus.

The new species, which is recognized by its circular-oblate leaves, retrose curly hairs disposed in two lines along stem and long showy corolla, at first appears to be a large-flowered element of *H. costatum* Gray var. *pulchellum* with which it is sympatric. Absence of plants which are intermediate between the two species suggest a higher degree of genetic differentiation between these two. *H. oblatifolia* is also similar to *H. johnstonii* which differs in lacking retrorse hairs occurring along the stem. The two are allopatric with the latter restricted to the mountains of northern Coahuila.

The three species of *Hedeoma* previously mentioned belong to the subgenus *Saturejoides* Irving, section *Saturejoides* Irving, and can be separated by the following key:

1. Corolla 9–12(–20) mm long; the stem covered with hairs on all sides ..... *H. costatum*
1. Corolla more than 30 mm long; the stem glabrous or not covered with hairs on all sides 2
   2. Leaves ovate-oblanceolate; hairs on stem restricted to the nodes ..... *H. johnstonii*
   2. Leaves oblate-circular; hairs on stem retrorse, occurring in two lines ..... *H. oblatifolia*

ACKNOWLEDGMENTS

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ROTTBOELLIA COCHINCHINENSIS (POACEAE: ANDROPOGONEAE) NEW TO TEXAS

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ABSTRACT

Rottboellia cochinchinensis (Lour.) W.D. Clayton (syn. = *R. exaltata* L.f.), previously unreported in Texas, has been found in Jefferson County. A key is provided to separate this taxon from similar genera of Texas Andropogoneae, as well as a description of the species.

RESUMEN

Rottboellia cochinchinensis (Lour.) W.D. Clayton (sinónimo de *R. exaltata* L.f.) previamente no citada en Texas, se ha encontrado en el Condado Jefferson. Se ofrece una clave para separar este taxon de géneros similares de Andropogoneae de Texas, así como una descripción de la especie.

Rottboellia L.f. contains four species native to the Old World Tropics which are adapted to a variety of habitats; swamps to dry woodlands and disturbed areas (Clayton and Renvoize 1986). *Rottboellia cochinchinensis* (Lour.) W.D. Clayton (syn. = *R. exaltata* L.f.), native to Southeast Asia, is a large annual that can reach a height of over 3 m and is an aggressive invader of disturbed areas. This species is commonly named "itchgrass" because of the presence of stiff irritating trichomes on the leaf sheaths.

Rottboellia cochinchinensis has been introduced into tropical and subtropical areas of Africa, Australia, Madagascar, West Indies, and North, Central and South America (Holm et al. 1977). In the United States it has been primarily confined to Florida and Louisiana (White et al. 1979; Hall and Patterson 1992), however it has also been reported from Alabama, Georgia, North Carolina (Talpas 1982; Millhollon 1983), Mississippi (Patterson and Quimbly 1978) and Arkansas (Khodayari et al. 1985). It was introduced into the United States at Miami, Florida (Chase 1951) and Louisiana. In Louisiana it was first observed in St. Martin Parish along a railroad track near the town of Ruth after a local flood in 1927 (Millhollon 1965). It is now reported to occur in 16 Louisiana parishes

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(Allen et al. 1991). This species has not been reported from Texas (Gould 1975; Hatch et al. 1990; Hall and Patterson 1992).

Rottboellia cochinchinensis, ranked as the 18th worst weed in the world, is a pest of 18 crops in 28 countries (Holm et al. 1977). It is a pest in sugarcane, corn, rice, cotton, peanuts, soybeans, bananas, cassava, citrus, cowpeas, papayas, pineapples and sorghum (Holm et al. 1977). This taxon is listed in the Federal Noxious Weed Act [7 CFR Part 360.200 (C)] and an aggressive pest of crops. It is important to monitor its movement, because of its economic threat.

During a botanical collecting trip in 1989 this taxon was collected in Calcasieu Parish, Louisiana (*Wipff 1467, S.&G. Jones*, TAES), about five miles from the Texas border. From the distribution given by White et al. (1979) and after obtaining additional distribution information from the Louisiana State University Herbarium (LSU) and Tulane University Herbarium (NO); we determined this collection to be the most western known site at that time. A Noxious Weed Survey, funded by the Texas Agricultural Extension Service in cooperation with the Cooperative Agricultural Pest Survey Program, was conducted in September 1992 to determine the status of *Rottboellia cochinchinensis* in Texas. During this survey a single population was found along the side of State Highway 73 in Port Arthur, Jefferson County. This population contained about 3,000 individuals and extended about 100 m along the side of the highway.

Rottboellia is in the tribe Andropogoneae Dumort. and subtribe Rottboelliinae Presl. This subtribe is delimited in Texas by the following characters: *Inflorescence* a cylindrical to flattened spicate raceme, usually fragile and disarticulating (breaking apart) at maturity (except for *Hemarthria* which does not break apart at maturity); internodes variously thickened or swollen. *Spikelets* paired and usually dissimilar. *Sessile spikelet* bisexual, dorsally compressed, two florets; first glume 2-keeled, convex; lower floret sterile or staminate, awnless; upper floret bisexual, awnless. *Pedicelled spikelet* variable; pedicel free or fused to the central axis internode of the inflorescence. In Texas, the following genera are classified in the subtribe Rottboelliinae: *Coelorachis*, *Elionurus*, *Eremochloa*, *Hemarthria* and *Rottboellia*.

The following is a key to Texas Andropogoneae, subtribe Rottboelliinae and similar genera.

KEY TO TEXAS ANDROPOGONEAE SUBTRIBE ROTTBOELLIINAE AND SIMILAR GENERA

1. Spikelets awned 2
1. Spikelets awnless 4
2(1). Awns less than 3 cm long, glabrous (scabrous) ..... *Schizachyrium*
2. Awns more than 3 cm long, at least the lower 1/2 of the awn pubescent 3
3(2). Inflorescence (excluding awns) 10–28 cm long; upper nodes densely pubescent; awn light colored, awn pubescence 1 mm or more long ..... *Trachypogon secundus*

3. Inflorescence (excluding awns) 4–7 cm long; nodes glabrous; awn golden brown to dark brown at maturity, awn pubescence less than 1 mm long ..... *Heteropogon*

4(1). Spikelets, in the upper 1/2 of the inflorescence, arranged on one side of the central axis of the inflorescence; both spikelets sessile at each node; inflorescence comprised of a spicate raceme or a panicle of 2–3 racemose branches ..... *Tripsacum dactyloides*

4. Spikelets on both sides of the central axis of the inflorescence; spikelets at each node consisting of one sessile and one pedicelled (the pedicelled spikelet is sometimes absent and only the pedicel remains); inflorescence a spicate raceme 5

5(4). Inflorescence pubescent ..... *Elionurus*

5. Inflorescence glabrous 6

6(5). Pedicelled spikelet slightly shorter to longer than the sessile spikelet; pedicel fused to the central axis internode of the inflorescence 7

6. Pedicelled spikelet less than 1/2 as long (or absent) as the sessile spikelet; pedicel free, not fused to the central axis internode of the inflorescence 8

7(6). Sheaths pubescent with stiff, straight, papilla based trichomes up to 3 mm long, which irritate the skin; plants annual, developing prop roots from the lower nodes; inflorescence fragile and breaking apart at maturity; apex of first glume of the pedicelled spikelet bifid ..... *Rottboellia cochinchinensis*

7. Sheaths glabrous; plants perennial, not developing prop roots; inflorescence tough, not breaking apart a maturity; apex of first glume of the pedicelled spikelet not bifid ..... *Hemarthria altissima*

8(6). Plants mat-forming, to 30 cm tall; stolons present; dorsal (abaxial) surface of first glume of sessile spikelet smooth ..... *Eremochloa ophiuroides*

8. Plants erect, not mat-forming, 30–130 cm tall; stolons absent; dorsal (abaxial) surface of first glume of sessile spikelet shallowly pitted to coarsely and irregular transverse ridges ..... *Coelorachis*

Rottboellia cochinchinensis (Loureiro) W.D. Clayton, Kew Bull. 35:817. 1981. (Fig. 1). TYPE: Cochin, China (now Vietnam [Hall and Patterson 1992]); whereabouts uncertain (Clayton and Renvoize 1982).

Stegosia cochinchinensis Lour., Fl. Cochin. 1:51. 1790.

Rottboellia exaltata L.f., Suppl. Pl. 114. 1781., non *R. exaltata* (L.) L.f., Nov. Gram. Gen. 23, 37. 1779. TYPE: "In indiis," *Thunberg*, (HOLOTYPE: LINN; Clayton and Renvoize 1982).

ITCHGRASS. Erect annual, 30–300 cm tall; lower 3–6 (7) nodes developing prop roots; *culms* glabrous or sparsely pubescent in upper portion of internode, branching from aerial nodes. *Leaves* cauline; *sheaths* pubescent on back with long, stiff, papilla-based trichomes 1.0–3.0 mm long and irritating the skin; *ligule* a ciliate membrane, 1.0–1.3 mm long, light brown; *blades* flat, (9) 20–50 (60) cm long, 10–20 (25) mm wide, glabrous abaxially; sparsely pubescent with short papilla-based trichomes adaxially, densely pubescent behind the ligule. *Inflorescence* a spicate raceme, (3) 6–15 cm long, 2–3.5 (4.0) mm wide, glabrous; 10–22 internodes, 6.0–12.0 mm long, disarticulation at the nodes at maturity, each internode or article (segments of a structure that separate at maturity) with a

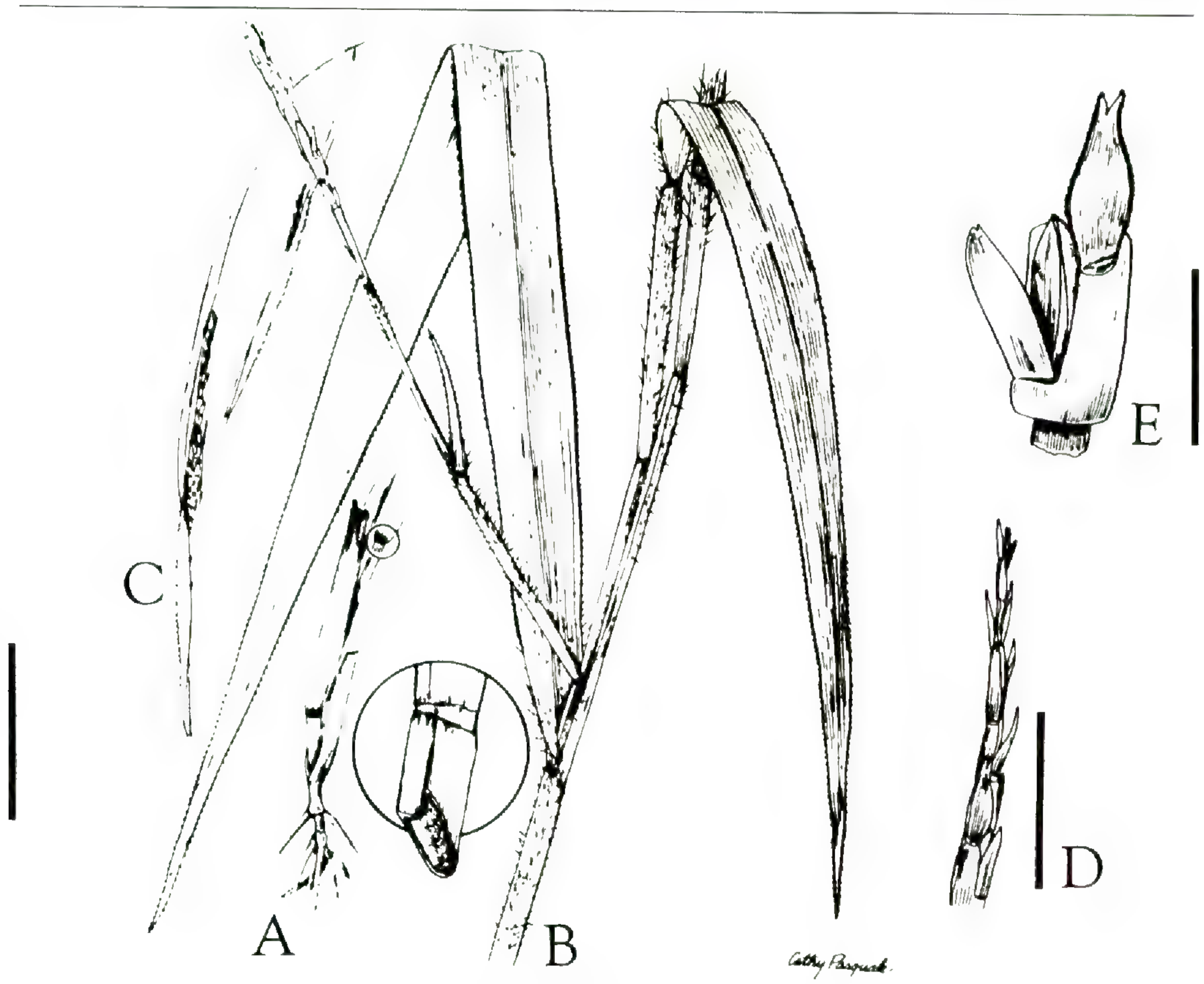

FIG. 1. *Rottboellia cochinchinensis*. Bar equals 4 cm for A–C. A. Lower portion of culm, showing prop roots (with inset showing solid stem); B. Upper portion of culm showing pubescence and spicate raceme; C. Young flowering branch; D. Top portion of inflorescence (Bar equals 1 cm); E. Floral unit [sessile spikelet, pedicellate spikelet, and internode (Bar equals 5 mm)] [modified from Webster (1990); source *Williams 2623* (NY)].

prominent basal callus-knob (peg); apex of peduncle expanded; inflorescence terminates in (3) 4–6 reduced spikelets, which become progressively smaller towards the inflorescence apex. *Spikelet*, awnless, two per node, one sessile and one pedicellate; sessile spikelet sunken into a hollow in the central axis internode; *Sessile Spikelets* (3.5) 4.0–6.0 (7.0) mm long, glabrous; *first glume* (3.5) 4.0–6.0 (7.0) mm long, 1.4–2.0 mm wide, 11–13 (–15)-veined with transverse veins at the apex, broadly convex to flat, margins revolute, coriaceous, apex bifid with teeth 0.2–0.6 (0.7) mm long; *second glume* 5.0–6.2 mm long, (–13) 15–17-veined with transverse veins at the apex, navicular (boat-shaped, shaped as the bow of a boat) and almost enclosing the two florets, glabrous, coriaceous. *Lower Floret* staminate, *stamens* 3, 2.2–2.3 mm long, purple/red; *lemma* 4.2–5.1 mm long, 1.2–1.7 mm wide, faintly 3-veined, 2-keeled, hyaline membrane, glabrous; *palea* 4.0–4.6 mm long, 1.2–1.7 mm wide, back coriaceous and margins membranous, glabrous.

Upper floret bisexual, *stamens* 3, 1.2–2.1 mm long, yellow to purple/red; *lemma* 4.0–5.2 mm long, faintly 3-veined; a hyaline membrane enclosing the flower, navicular (boat-shaped, shaped as the bow of a boat), glabrous; *palea* absent. *Stigmas* purple. *Caryopses* 3.0–3.2 (4.0) mm long, 2.0–2.2 mm wide. *Pedicellate Spikelet* (3) 3.5–7.4 (8.0) mm long, neuter; *pedicel* (3) 3.5–6.5 mm long, 1.5–2.2 mm wide, flat, glabrous, fused to central axis internode; *first glume* (3) 3.5–7.4 (8.0) mm long, ca. 19-veined, herbaceous, 2-keeled, flat, antrorsely scabrous on the keels; apex bifid, teeth 0.6–1.1 (1.4) mm long; *second glume* 3.5–4.5 mm long, 5–9-veined, minutely pubescent on back, herbaceous. *Lower floret* neuter, *lemma* 3.0–3.5 mm long, faintly 3-veined, a hyaline membrane; *palea* 0.8–2.0 mm long, 0-veined, a hyaline membrane, glabrous. *Upper floret* neuter, *lemma* 1.6–2.5 mm long, 0-veined, a hyaline membrane, glabrous; *palea* 0.6–1.1 mm long, 0-veined, hyaline membrane, glabrous.

Specimen collected: UNITED STATES. Texas. **Jefferson Co.:** NW corner of the intersection of FR 823 and Hwy 73 in Port Arthur, disturbed roadside, 24 Sept 1992, *Wipff 2459 & E.J. Taylor* (BRIT/SMU, TAES, TEX, US). The population starts at the intersection of FR 823 and Hwy 73 and goes W for ca. 100 m along Hwy 73 and has an estimated 3,000 plants. Associated species: *Sorghum halepense* (L.) Pers., *Cenchrus echinatus* L., *C. incertus* M.A. Curtis, *Sporobolus indicus* (L.) R.Br., *Paspalum dilatatum* Poir., *Bothriochloa ischaemum* (L.) Keng and *Cyperus sp.*

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A NEW SPECIES OF *AGALINIS* (SCROPHULARIACEAE) FROM GRIMES COUNTY, TEXAS

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ABSTRACT

Agalinis navasotensis Dubrule & Canne-Hilliker is described from a sandstone outcrop in Grimes County, Texas. It is morphologically most similar to the Louisiana species, *A. caddoensis* Penn., from which it differs primarily in characters of the inflorescence, calyx, and corolla. The plant and its unusual habitat are described. A table and a key are provided to distinguish *A. navasotensis* from similar *Agalinis* of Texas and neighboring areas.

RESUMEN

Se describe *Agalinis navasotensis* Dubrule & Canne-Hilliker que crece en afloramientos de areniscas en el Condado Grimes, Texas. Morfológicamente es muy similar a *A. caddoensis* Penn. de Louisiana, de la cual se diferencia principalmente por caracteres de la inflorescencia, cáliz y corola. Se describen la planta y su habitat particular. Se incluyen un cuadro y una clave para distinguir *A. navasotensis* de las especies parecidas de *Agalinis* de Texas y de áreas cercanas.

INTRODUCTION

The genus *Agalinis* comprises some 40 species in temperate America and is the largest and most complex genus of the Scrophulariaceae in the eastern United States (Holmgren 1986; Mabberly 1987). The *Manual of the Vascular Plants of Texas* (Correll & Johnston 1970) lists 15 species for Texas. Checklists updating the manual list the same number (Johnston 1988) or bring the number to 17 with the inclusion of species treated by the manual under *Tomanthera* Raf. (Hatch, et al. 1990).

During preparation of a treatment of the Scrophulariaceae of Brazos County, TX and surrounding counties, a specimen (*Ajilvsgi 8510*) was found at TAMU with a determination of *A. viridis* but which could not be keyed to any known Texas species of *Agalinis*. The location cited was a familiar rock outcrop in Grimes

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County and a visit to the outcrop revealed a population of plants with the same morphology as the Ajilvsgi specimen. These plants, also, could not be identified as belonging to any species listed for Texas. The possibility that the plants were edaphic variants of some known species was considered. However, plants grown in hydroponic culture from seeds taken from outcrop plants exhibited the same characteristics as those at the collection site.

Subsequent seasons of field work, laboratory investigations, and herbarium study, including examination of type specimens, have convinced us that the Grimes County plants represent a new species of *Agalinis*, hereafter treated under the name *A. navasotensis* Dubrule & Canne-Hilliker.

Agalinis navasotensis Dubrule & Canne-Hilliker, sp. nov. (Figs. 1–7)

Agalinis caddoensis similis sed plantis tenuioribus atque foliis caulium usque 4 cm longis valde recurvatisque; tubo calycis obconico vel infundibulari 2.6–3.7 mm longo; corolla (13)16–21(27) mm longa; thecis antherarum adaxialum in filamentis oblique collocatis et saepe 1–2 appendicibus apicalis sterilibus. In solis non profundis lapis arenariis expositis endemicis.

Similar to *Agalinis caddoensis* but the plant finer and with stem leaves to 4 cm long and often sharply recurved; calyx tube obconic to funnelform, 2.6–3.7 mm long, corolla (13)16–21(27) mm long; thecae of adaxial anthers obliquely placed on the filament and often with 1 or 2 sterile apical appendages; endemic to sandstone outcrops in shallow soil.

DESCRIPTION

Annual herb from a few fibrous roots, 2.8–9.0 dm tall, often tinged with purple, maroon, or bronze, *darkening little if at all on drying* if promptly pressed. Stem erect or sometimes declined, single from the base, divaricately branched above, terete to slightly angled below the branches, quadrangular-striate above, minutely scabridulous below and sparsely to moderately so above along the angles and sides. *Axillary fascicles absent*. Leaves opposite, spreading to ascending or often recurved, *filiform*, narrowly U-shaped in cross-section, 0.5–1(1.2) mm broad, 1.2–3(4) cm long, acute to acuminate, minutely scabrous with silicified hairs on adaxial surface and midvein below, margins silicified and scabrous. Inflorescence racemose or more commonly *paniculate with racemose branches*. Racemes or branches with up to ca. eight floriferous nodes, terminated by leaves or bracts, *no flowers appearing terminal*, flowers solitary or paired at the nodes; if paired, one usually blooming much later than the other. Pedicels slender, terete, spreading or ascending, glabrous to minutely scabridulous with silicified 1- or 2-celled hairs, at anthesis (6)8–21 mm long, usually longer than 10 mm and always longer than the calyx, elongating to ca. 2.5 cm in fruit. Calyx at anthesis *obconical to somewhat campanulate or funnelform, straight-sided*, often appearing truncate with minute teeth; tube 2.2–3.7 mm long, 3–4.4 mm broad, unribbed, exterior glabrous, interior with a narrow band of capitate hairs below the sinuses and lobes;

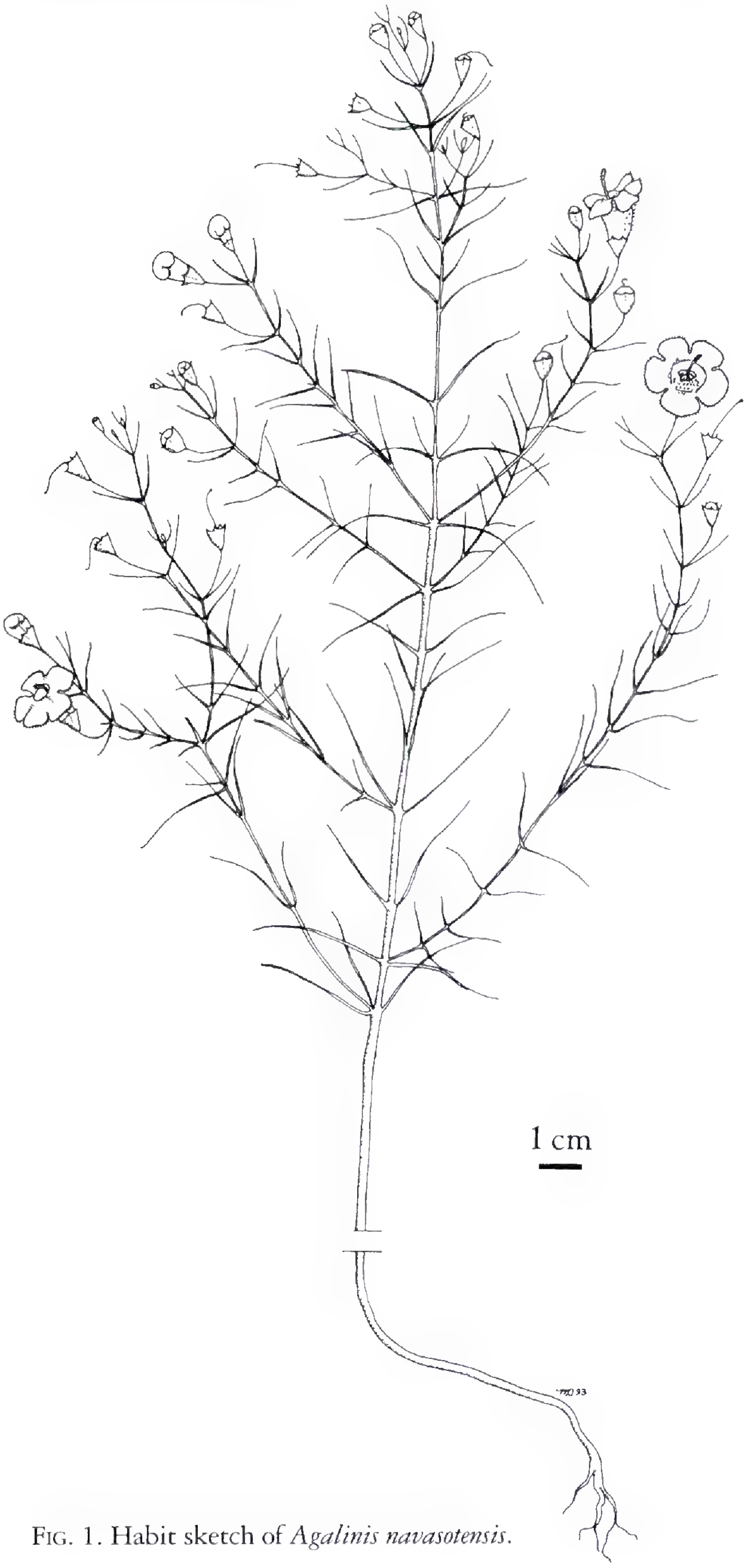


FIG. 1. Habit sketch of *Agalinis navasotensis*.

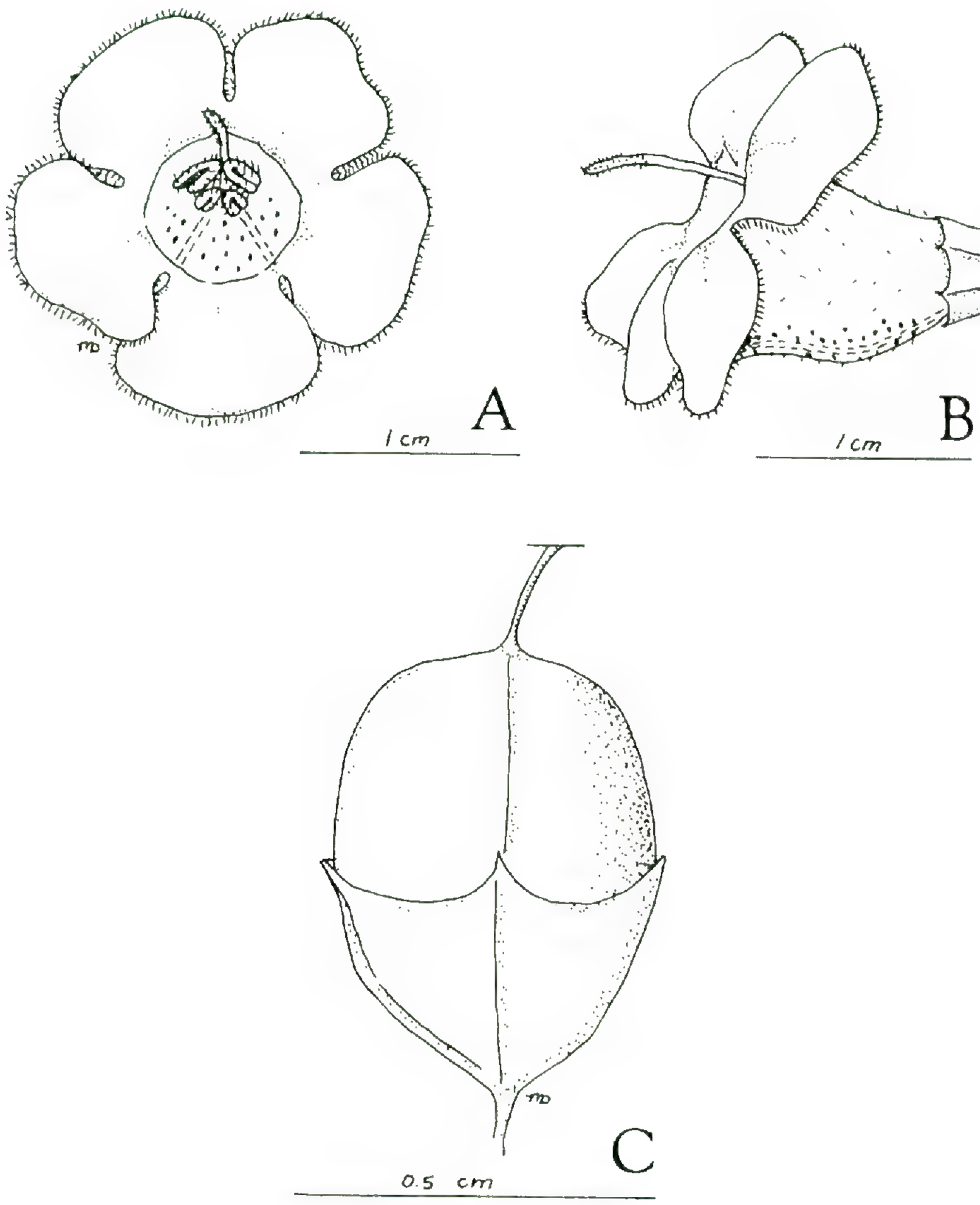


FIG. 2. *Agalinis navasotensis*. A. Corolla, front view; B. Corolla, side view; C. Capsule with persistent calyx.

lobes triangular-subulate, 0.5–1.5 mm long, acute, puberulent within with white silicified hairs, sinuses broad and straight to slightly concave. Relatively larger- and smaller-flowered plants present, but corolla size not correlating with position on the outcrop or size of the plant. Corolla including lobes (13)16–25(27) mm long, lavender- to rose-purple, paler in the larger blossoms and darker in the smaller, throat paler than lobes, with darker spots and two pale yellow lines abaxially; tube 2–3.5 mm long, narrow, glabrous; throat upcurved, the lower side slightly gibbous, *pilose externally* and within in a short, narrow longitudinal band just below the sinus of the adaxial lobes and in a narrow horizontal band among the filament bases; *lobes all spreading or spreading-reflexed, subequal or the lower lobes the longest*, ca. 6–9 mm long, ca. 0.5–2.5 mm longer than the upper, all glabrous except for the densely ciliate margins. Stamens 4, didynamous, abaxial filaments 9–11 mm long, villous; adaxial filaments 5–6 mm long, sparingly villous.

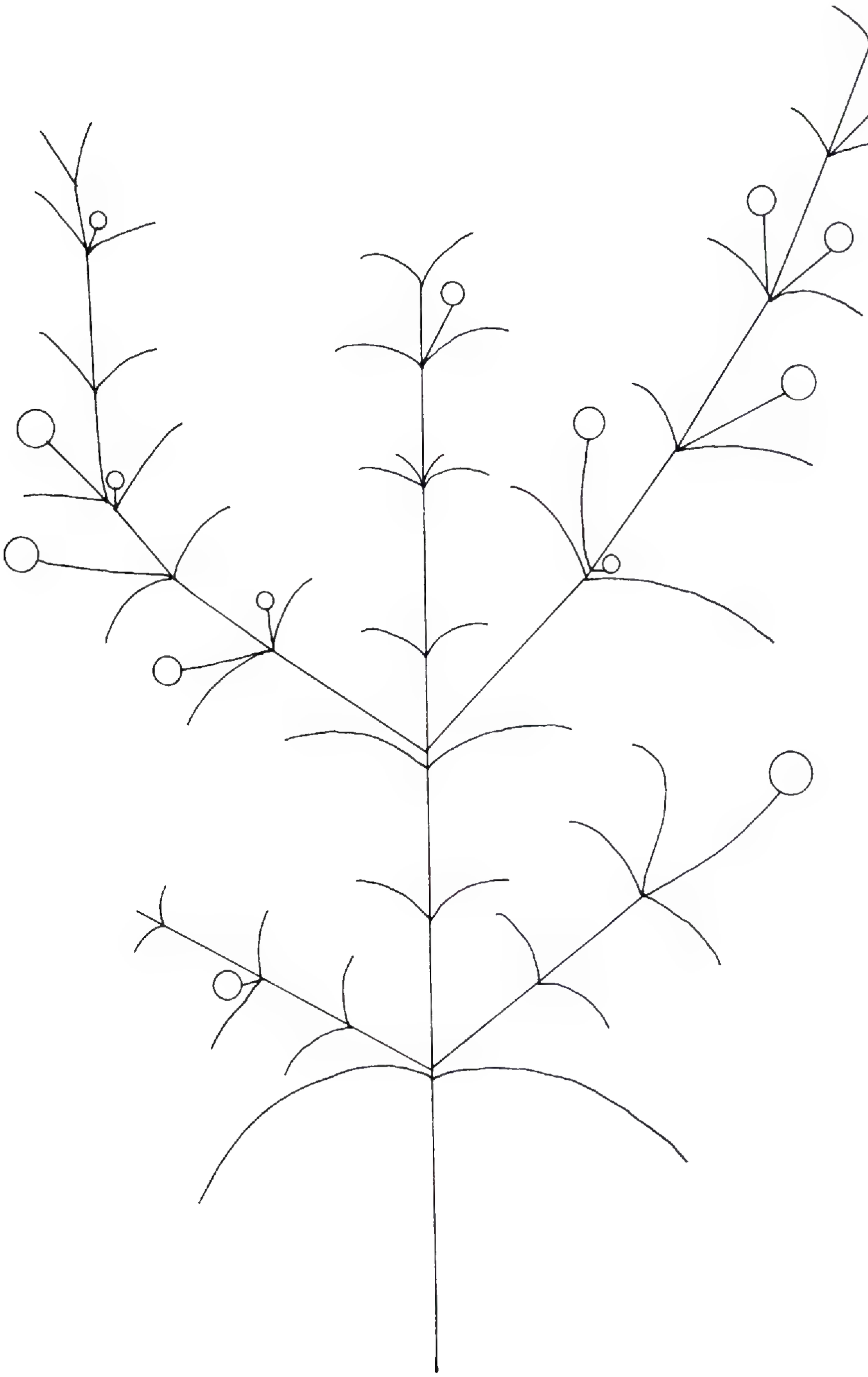
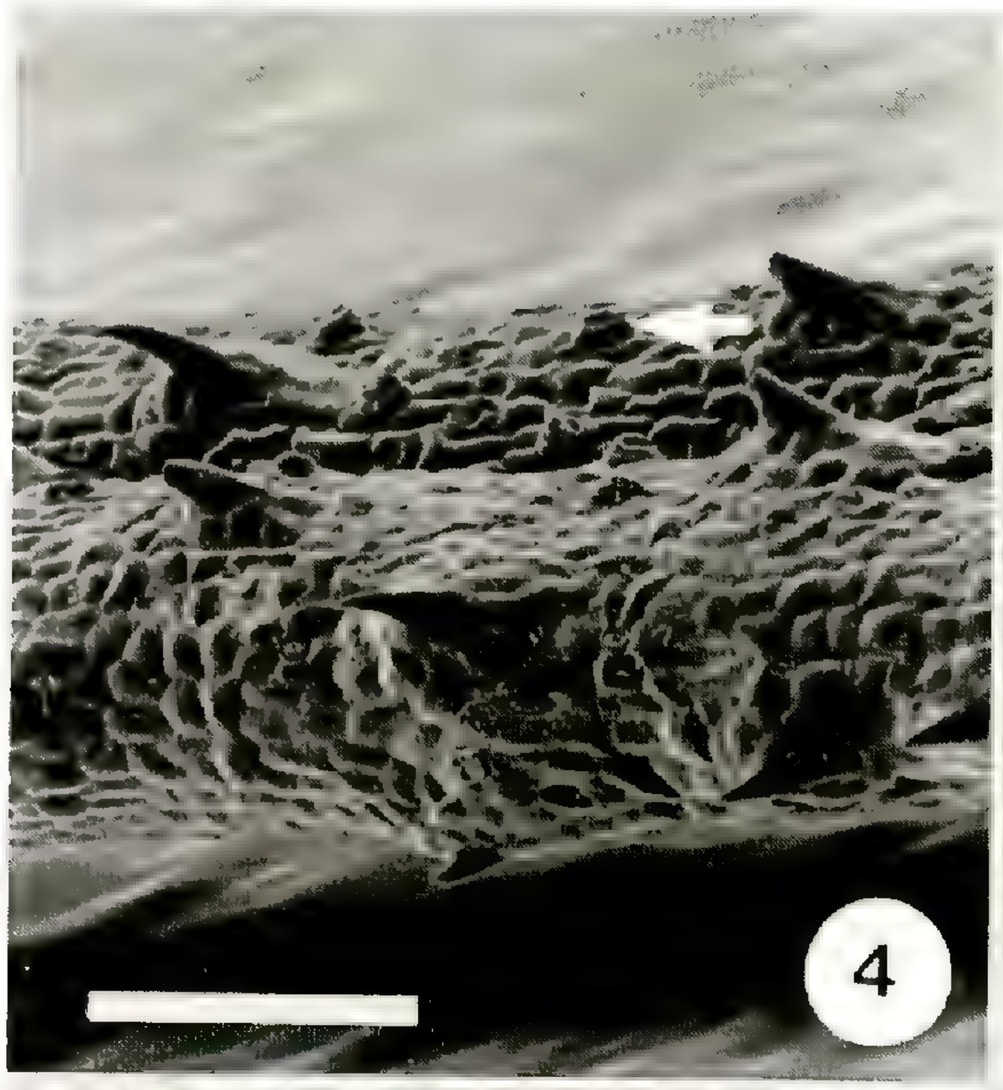
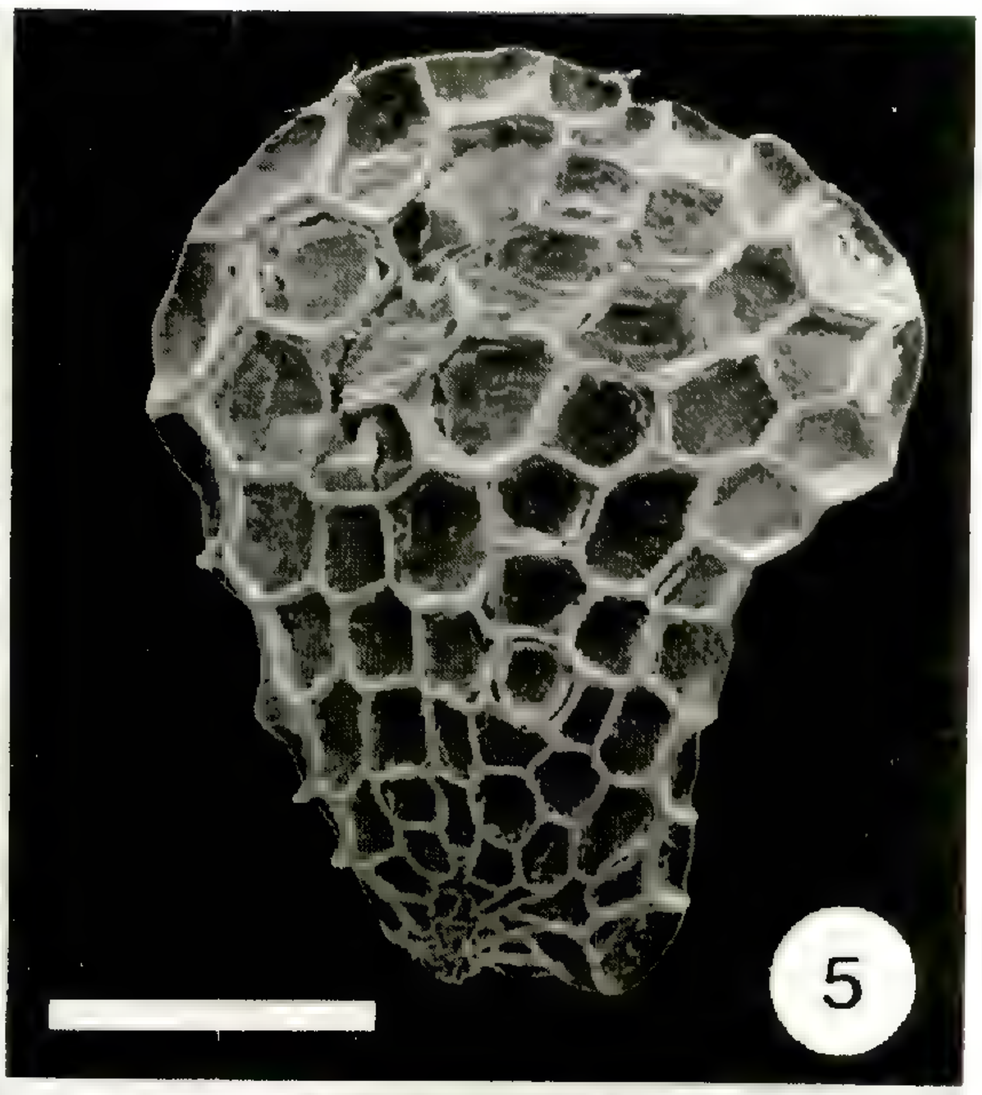
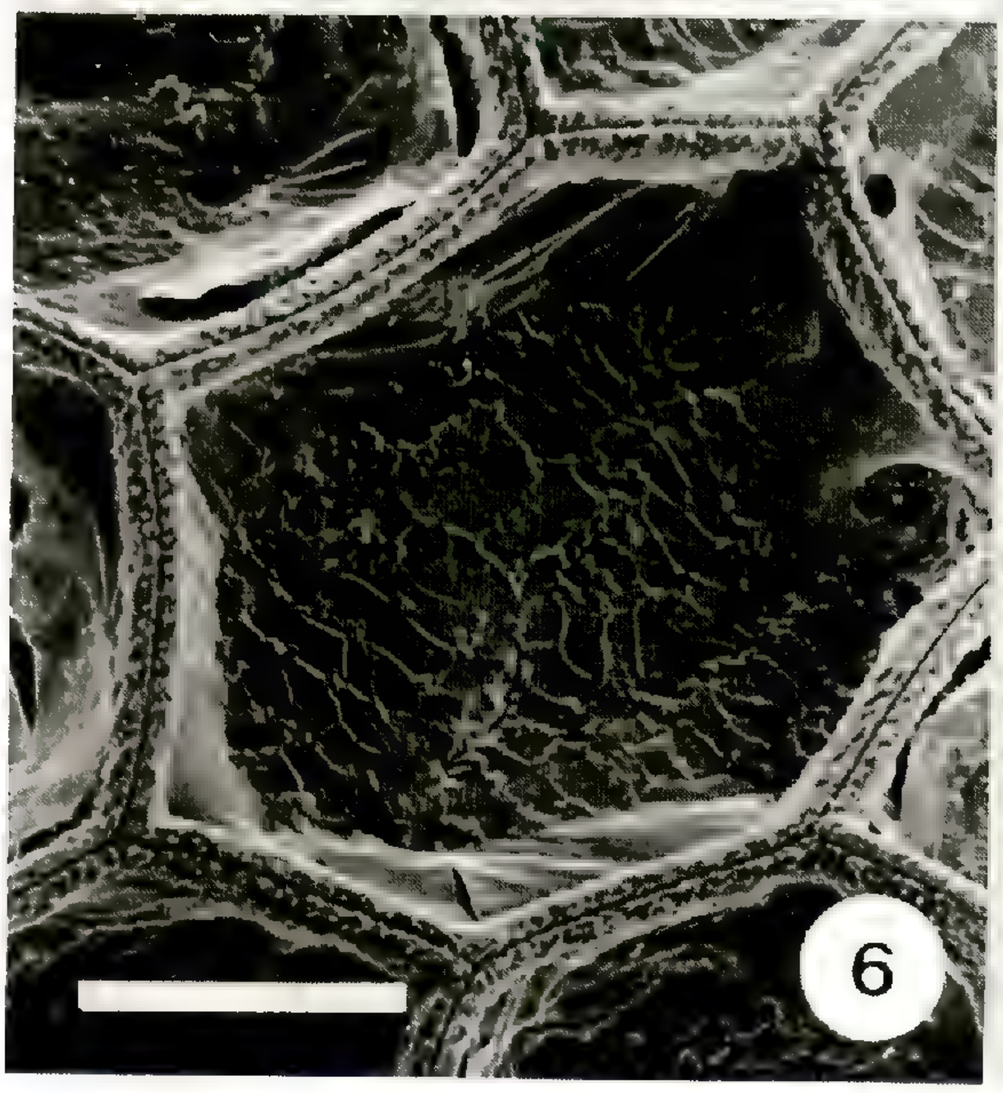
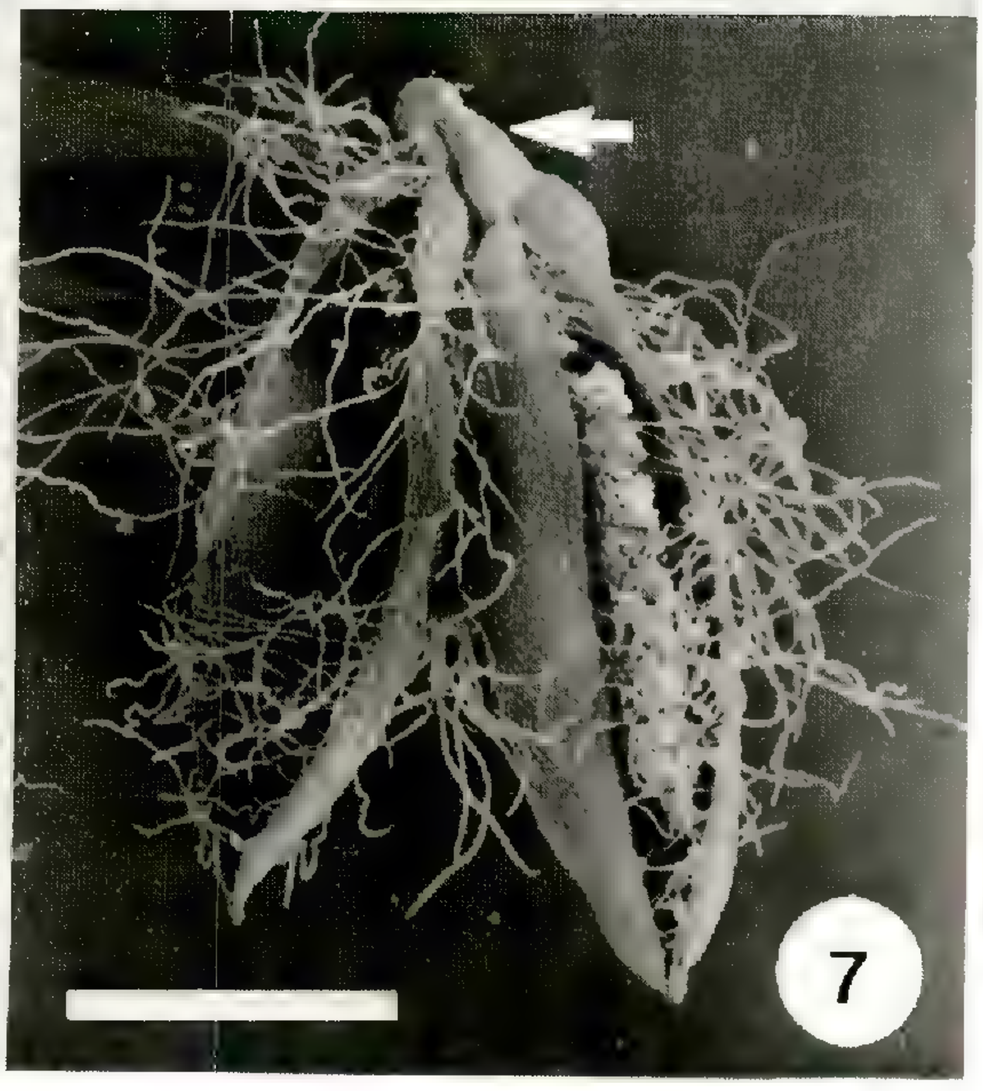


FIG. 3. Diagram of a portion of a well-developed inflorescence of *Agalinis navasotensis*. Circle size is proportional to age of flower.









FIGS. 4–7. Scanning electron micrographs of leaf, seed, and anther of *Agalinis navasotensis*. 4. Adaxial surface of leaf with sessile (arrow) and ornithorhynchous trichomes. Scale bar = 250 µm. 5. Seed. Scale bar = 0.5 mm. 6. Testal cell of seed showing outer tangential wall collapsed onto thickenings on the inner tangential. Scale bar = 75 µm. 7. Adaxial anther showing obliquely positioned thecae and sterile apical appendage (arrow). Most hairs were removed to reveal form of thecae. Scale bar = 1.2 mm.

Anthers of abaxial stamens usually coherent by entangled hairs; thecae villous, 2–3.2 mm long, *those of adaxial anthers placed one slightly above the other on the filament and with 1 or 2 terminal sterile appendages to 0.5 mm long, also with a basal mucro to 0.3 mm long*. Style to 1.5 cm long, pubescent; stigma 2–4.5 mm long, densely yellow-papillate. Capsule 4–7 mm long, conspicuously longer than the calyx, 4–4.5 mm broad, ovoid-or obovoid-oblong. Seeds 0.8–2.3 mm long, dark brown, irregularly trapezoidal, testa reticulate, radial walls of reticulae densely spinulose-

thickened, inner tangential walls with an irregular pattern of spinulose thickenings. Pollen spherical when wet, 6–6.8 μ in diam., ellipsoid when dry, stainability greater than 90%. Chromosome number $2n = 26$.

TYPE: TEXAS. **Grimes Co.:** outcrop on FM 3090, 0.2 mi NE jct FM 3455, NE of Navasota, sand-limestone outcrop, full sun, thin soil, 28 Sep 1992, *Dubrule 1062-D* (HOLOTYPE: TAMU; ISOTYPES: to be distributed to ASTC, BRIT, LSU, MO, NLU, NY, OAC, PH, SBSC, TAES, and TEX.

MATERIALS AND METHODS

Preparation of field collected samples for observation by SEM, and paraplast embedding and sectioning of stems and leaves follow procedures in Canne-Hilliker and Kampny 1991. Chromosome counts of mitotic cells were made from root tips excised from seedlings grown in petri plates and from plants grown in hydroponics. Pretreatment and staining procedures are given in Canne 1981. Type specimens of all species of *Agalinis* discussed herein have been examined by JMC-H. Seedling morphology was observed on 50 plants in which the first pair of cauline leaves were less than 3 mm long. Measurements were made with an ocular micrometer on a Wild M8 dissecting microscope. Trichome morphology was observed on seedlings placed in water on depression slides and viewed on a Zeiss standard research microscope. Pollen viability was estimated by staining pollen with lactophenol cotton blue.

RESULTS AND DISCUSSION

Agalinis navasotensis is placed in section *Purpureae* subsection *Pedunculares*. As delimited by Pennell (1929, 1935) and realigned by later workers (Canne 1979, 1981, 1983, 1984; Canne-Hilliker and Kampny 1991), this subsection includes *A. peduncularis* (Benth.) Pennell, *A. gypsophila* B. L. Turner, *A. pulchella* Pennell, *A. caddoensis* Pennell, *A. edwardsiana* Pennell, *A. homalantha* Pennell, *A. strictifolia* (Benth.) Pennell, and perhaps *A. aspera* (Benth.) Britton. These are annual plants (with the exception of *A. gypsophila*) with linear to filiform, usually scabrous leaves, pedicels usually 2–4 times longer than the subtending bracts and always longer than the calyx at anthesis, calyx lobes triangular-subulate and much shorter than the calyx tube, corollas ca. 2–3 cm long, capsules globose to ovoid or oblong, and seeds brown with a loosely adherent, reticulate seed coat. *Agalinis peduncularis* and *A. gypsophila* are Mexican species; the others are found in the central and southeastern U.S.

The leaves of *Agalinis navasotensis* are filiform and narrowly U-shaped at mid-blade in transverse section. Phloem fibers and xylem sclereids are absent from the massive midvein. The mesophyll consists of 3–4 cell layers of palisade parenchyma and 5–7 cell layers of spongy parenchyma. At the leaf margins and on abaxial epidermal cells overlying the mid-vein the outer tangential and radial cell walls are silicified. Leaves are amphistomatic. The leaves of *A. navasotensis* bear

sessile, anvil, ornithorhynchous, and obtuse trichomes (Fig. 4) typical of most other species of *Agalinis* (Canne-Hilliker and Kampny 1991). Leaf anatomy is consistent with that known for other members of subsect. *Pedunculares* (Canne-Hilliker and Kampny 1991). The filiform leaves are morphologically most similar to those of *A. caddoensis*. Other species in the subsection have linear to broadly linear leaves. The stem anatomy is like that recently reported for other members of the subsection (Canne-Hilliker and Kampny 1991).

The seedlings of *A. navasotensis* have oblong cotyledons 1.8–2.5 mm long, making them the largest cotyledons recorded among the 19 species of *Agalinis* for which seedling data are known (Canne 1983). The trichome complement is distinctive as well. Acute trichomes similar to those on the cotyledons of related *A. pulchella* and *A. strictifolia* (but not *A. edwardsiana*) are present, as are the dome-shaped trichomes present on cotyledons of all examined species. Cotyledons of *A. navasotensis*, like those of *A. edwardsiana*, lack the capitate trichomes found in *A. pulchella* and *A. strictifolia*.

The seeds of *A. navasotensis* vary in shape and size dependent upon position within the capsule (Fig. 5). They are morphologically similar to seeds of related species in subsect. *Pedunculares* (Canne 1979) but differ in details of testal cell shape as well as ornamentation of the radial cell walls and the pattern of thickenings on the inner tangential walls. The latter thickenings are slender, sparingly spinulose, and form a pattern of small polygons and circles (Fig. 6).

All of the numerous individuals of *A. navasotensis* examined show a mitotic chromosome number of $2n = 26$. This is consistent with previously reported counts for *A. edwardsiana*, *A. pulchella*, *A. strictifolia* (Canne 1981, 1984) and *A. aspera* (Löve and Löve 1982).

Agalinis navasotensis differs from all other members of the section in several respects (Table 1, Appendix 1). The plants tend not to darken upon drying. Such discoloration is characteristic of most other *Agalinis* and of many other Scrophulariaceae as well. Sterile terminal appendages occur on the thecae of the adaxial anthers in several species of subsect. *Pedunculares* but no others have the offset placement of thecae seen in *A. navasotensis* (Fig. 7). As noted above, the micromorphology of the seed coat is distinctive (Fig. 6), as with most species of the subsection (Canne 1979). Neither capsules nor seeds are present on any of the specimens of *A. caddoensis*. Because extant populations of this species are not known, fruit and seed data are lacking. We have not seen seeds of *A. gypsophila*.

The inflorescence of *A. navasotensis* is also distinctive. All species in the subsection except *A. pulchella*, *A. caddoensis*, and *A. navasotensis* produce well-developed racemes with 4 to 10 nodes. Most species produce only one flower on at least some of the nodes. The short racemes of *A. pulchella* and *A. caddoensis* often have uppermost flowers that appear terminal. Branching within racemes is uncommon except in *A. strictifolia* which has numerous short, lateral branches

with often secund flowers, and in *A. navasotensis* in which racemes are short and often interrupted by short, flowering, lateral branches. Uppermost flowers in this species do not appear terminal. Figure 3 illustrates a portion of the "paniculate" inflorescence of *A. navasotensis*.

Agalinis navasotensis most closely resembles (and in most treatments will key to) *A. caddoensis*, a plant of northwestern Louisiana not seen alive since its first collection by F.W. Pennell in 1913. MacRoberts (1978) reduced *A. caddoensis* to a synonym of *A. strictifolia* (Benth.) Penn., but it clearly does not belong to this species (see Table 1 and Appendix 1) and most authors since have maintained it as a separate species (e.g., Vincent 1982). *Agalinis navasotensis* may be distinguished from *A. caddoensis* on the following basis: plants more delicate, the primary stem leaves often longer and recurved; inflorescences racemose-paniculate and not solely racemose; calyx obconic and not hemispheric; flowers smaller; anthers smaller and the thecae of the adaxial pair obliquely offset.

The features separating *A. navasotensis* from the Texas species of subsection *Pedunculares* and from other narrow-leaved, long-pediceled *Agalinis* from Texas are summarized in Table 1. Appendix 1 provides a dichotomous key to the narrow-leaved, long-pediceled *Agalinis* of Texas and to other species of subsect. *Pedunculares*.

HABITAT INFORMATION

Agalinis navasotensis is presently known from only one population ca. 3.2 miles northeast of Navasota in Grimes County in east-central TX. An estimated 100 to 200 individuals are growing in full sun on a southeast-facing rock outcrop, immediately adjacent to FM 3090. Keeney (1967) conducted a survey of the flora and geology of the site. The substrate is a sandstone representing the easternmost escarpment of the Miocene Oakville formation. It was laid down as layers of alluvium washed from Cretaceous outcrops and contains large amounts of shell and foraminifera sediments. The soil is shallow and sandy. Keeney (1967) determined the pH to range from 7.4–7.6. Keeney reported that at the time of his work, the area had never been cultivated and had not been grazed since 1958; neither is it currently being cultivated or grazed.

The outcrop represents a distinct floral unit—an "island" in the surrounding "sea" of Post Oak Savannah, Blackland Prairie, and farmland of the Navasota River valley. Table 2 presents a partial taxon list for the site. Many of the plants listed are largely confined to calcareous soils or outcrops and are more typical of the Edwards Plateau region or calcareous regions of South Central Texas. For example, the outcrops near Navasota are the only sites known in Grimes County for *Lesquerella densiflora*, *Coryphantha missouriensis*, and *Lygodesmia texana*.

This habitat differs greatly from that of the type location for *Agalinis caddoensis*, which was described as a dry loam oak wood along Kansas City Southern

TABLE 1. Comparison of *Agalinis navasotensis* with similar taxa.

TAXON	A.F.[1]	LEAVES[2]	INFLORESCENCE	PEDICEL[3]	CALYX[4]
A. gattingeri *n*=13	-	linear 20–30 × 1.2	raceme, 1–5 flrs 1/node, upper look terminal	2–30 filiform	campanulate, 2.5–3.5
A. viridis	-	linear, erect-ascending, flat to sl. revolute 15–28 × 1.3	raceme, 2–15 flrs (1)2/node, upper look terminal	2–22 ascending	obovoid-campanulate, 3.5–4
A. pulchella *n*=13	+	linear-subfilif. spreading 20–30 × 0.4–1.0	raceme, 4–6 flrs 1–2/node, upper may look terminal	11–30 ascending-spreading	hemispheric, 3–4
A. strictifolia *n*=13	-	linear, spread-reflexed; on fl. branches appressed 20–35 × 1.0–3.0	raceme, 4–10 flrs 1–2/node	10–25 ascending-spreading	campanulate-hemispheric, 3–4
A. homalantha	+	linear, revolute 20–40 × 0.7–1.5	long raceme, 3–10 flrs, upper flrs may look terminal	(6)10–33 ascending-spreading	campanulate-hemispheric, 3–4
A. eduardsiana *n* 13	-	linear 20–35 × 0.5–0.9	+/- long raceme, 2–9 flrs	30+ ascending-spreading	hemisphic, 3.5–4.5
A. tenuifolia *n*=14	-(+)	linear, flat to ~revolute, spreading 20–50(100) × 1–6	elongate raceme, 2–23 flrs 2/node	(4)7–30 arched-ascending	campanulate-hemispheric, 2–4
A. caddoensis	-	filiform, U-shape 20–33 × 0.8	interrupted rac. 1–5 flrs, many look terminal	(5)10–22 ascending-spreading	hemispheric-campanulate, (3)3.5–5.5
A. navasotensis *n*=13	-	filiform, U-shape recurved or upcurved 12–30(40) × 0.5–1.0(1.2)	racemose-panicle to ~8 flrs, 1–2/node (diff. times) few if any look terminal	(6)8–21 ascending-spreading	obconic, 2.2–3.7

[1]presence (+) or absence (-) axillary fascicles; [2]leaf shape and l × w in mm; [3]pedicel length in mm and orientation; [4]calyx shape and length in mm

CA LOBES[5]	COROLLA[6]	ANTHERS[7]	STIGMA[8]	FRUIT[9]	HABITAT
Δ to Δ-subulate (0.2)0.5–1.5	12–20, upcurved, lobes equal, spreading	1.3–2 b. awn 0.2–0.5	(1)2–3	globose/ gl-ovoid 4–5	sand-clay slopes, woods
Δ-lance to lanceolate 1.5–2	7–14, upcurved, lobes equal, spreading, 2–4	0.9–1.5 b. mucro 0.1–0.3	1.0–1.3	globose-ovoid (4.5)5–7	sandy-clay, pine & hardwood forest
subulate, recurved to 0.5(0.9)	15–(27)30, upcurved, lobes equal, 9–12	2.5–3.7 b. awn 0.3–0.8	2(3–4)	globose/ gl-ovoid 5–6	sand/clay, grassland, pine or mixed woods
Δ-lance-subulate 1–2	20–25, strongly upcurved, lobes 8–10	———	———	quadrate ca. 6	sandy, open mesquite & scrubland
lance-acum./ Δ-lanceolate Δ-subulate oft. reflexed 0.5–1.2	(14)18–27, straight, posterior lobes forward, 3–4; anterior 8–9	3–4 b. awn 0.5–0.8	1–2(4)	subglobose/ gl-ovoid (4)5–7	sandy/clay, oak or pine woods, fields
Δ-subulate/ subulate-acute 0.5	20–23, straight, posterior lobes forward, 5–6; anterior 8–9	———	———	globose/ gl-obovoid 6–7	thin soil, adobe or lime
wide-Δ to subulate 0.2–1.5(2.3)	7–23, all lobes equal, forward or anterior spreading	1.5–2.3 (3.0)	1–2	globose 3–7(8)	moist or dry clayloam, woods, fields
Δ-subulate 0.7–0.1	20–30, upcurved, lobes equal, 6–7	3–4 b. mucro to 0.3	3–5	———	dry loam oak woods
Δ-subulate 0.5–1.5	(13)16–25(27), upcurved, posterior lobes shorter	2–3.2 b. mucro to 0.3 thecae of short sts. uneven, a. appen. to 0.5	2–4(4.5)	ovoid/ obovoid/ oblong 4–7	calcareous sandstone out-crop, sun

[5]calyx lobe shape and length in mm; [6]corolla length in mm, shape, lobe shape and length in mm; [7]anther length in mm and presence of basal (b.) or apical (a.) appendage and its length in mm; [8]stigma length in mm; [9]fruit shape and length in mm.

TABLE 2. Taxa associated with *Agalinis navasotensis*.

Agalinis heterophylla (Nutt.) Small ex Britt. & A. Br.
Ambrosia trifida L. var. *texana* Scheele
Amphiachyris dracunculoides DC.
Aphanostephus skirrhobasis (DC.) Trel.
Arenaria patula Michx. var. *patula*
Aristolochia erecta L. (*A. longiflora*)
Astragalus nuttallianus DC. var. *austrinus* (Sm.) Shr. & Wigg.
Bifora americana (DC.) Benth. & Hook.
Bouteloua gracilis (Kunth *in* HBK.) Lag. ex Griffiths
Calylophus berlandieri Spach subsp. *berlandieri*
Castilleja indivisa Engelm.
Celtis reticulata Torr.
Chaetopappa asteroides Nutt. ex DC.
Commelina erecta L
Coryphantha missouriensis (Sweet) Britt. & Rose
Croton monanthogynus Michx.
Dactyloctenium aegyptium (L.) Beauv.
Dalea compacta Spreng. var. *compacta*
Dichanthelium sp.
Engelmannia pinnatifida Nutt.
Eragrostis sp.
Erigeron strigosus Muhl. *ex* Willd.
Euphorbia bicolor Engelm. & Gray
Evax verna Raf.
Gaura parviflora Hook.
Hedeoma reverchonii Gray var. *reverchonii*
Hedyotis nigricans (Lam.) Fosb.
Hymenopappus scabiosaeus L'Her.
Juniperus virginiana L.
Krameria lanceolata Torr.
Lupinus subcarnosus Hook.
Lepidium virginicum L.
Lesquerella densiflora (Gray) S. Wats.
Lesquerella gracilis (Hook.) Wats. var. *gracilis*
Linum rigidum Pursh var. *berlandieri* (Hook.) T. & G.
Lygodesmia texana (T. & G.) Greene
Manfreda sp.
Marshallia caespitosa DC. var. *caespitosa*
Mentzelia oligosperma Sims
Morus sp.
Nothoscordum bivalve (L.) Britt.
Opuntia sp.
Pediomelum rhombifolium (T. & G.) Rydb.
Penstemon cobaea Nutt.
Polanisia dodecandra (L.) DC. subsp. *riograndensis* Iltis
Polygala alba Nutt.
Rhus aromatica Ait. var. *flabelliformis* Shinners
Rhus toxicodendron L.
Scutellaria drummondii Benth.
Solidago sp. (*canadensis* ?)
Tetraneuris linearifolia (Hook.) Greene
Thelesperma filifolium (Hook.) Gray
Triodanis perfoliata (L.) Nieuwl. var. *perfoliata*
Ulmus americana L.
Valerianella sp.
Verbena halei Small
Vicia minutiflora Dietr.
Vitis mustangensis Buckl.
Yucca sp.
Zanthoxylum sp.

Railroad, 2–3 miles northwest of Shreveport, Caddo Parish, LA. (Pennell 1921). The extreme differences in habitat and the morphological differences outlined above make it highly unlikely that the Grimes County population is conspecific with *A. caddoensis*.

HISTORY

Keeney (1967) listed *Agalinis aspera* (Benth.) Britton (as *Gerardia asper* Dougl. *ex* Benth. *in* DC.) as occurring on the outcrop. *A. aspera* is a narrow-leaved species which does not occur in Texas (but which is listed in the taxonomic references available to Keeney at that time.) Because the herbarium in which Keeney's specimens were deposited (SHST) was destroyed by fire in 1978, it is not known whether he saw locally common *A. heterophylla*, *A. navasotensis*, or both on the outcrop.

The earliest known specimen of *A. navasotensis* (dating from 1983) is the

misidentified Ajilvsgi specimen mentioned previously. Additional specimens were collected by the junior author from the type locality in the autumns of 1990, 1991, and 1992. An examination of herbarium sheets of *Agalinis* from SBSC and BRIT has revealed two more collections, both by Larry E. Brown from the type locality (*Brown 8065, 9613*). Collected in 1984 and 1985, respectively, these were originally identified as *A. gattingeri* (Small) Small.

In the fall of 1992, a second site was discovered. This second location is essentially the northern face of the same outcrop. Approximately 30 individuals were seen in flower growing with *Agalinis heterophylla* and *Euphorbia bicolor* on a badly eroded, sandy, rocky hillside in full sun. (VOUCHER: Texas. Grimes Co.: County Road 403, 0.5 mi N jct. FM 3090, NE of Navasota, 12 Sept 1992. *Dubrule 1046*). Because these plants are within approximately one mile of the main group at the type locality, they are well within bee-flight range for pollination purposes, and are therefore considered to be part of the same population. At the same time, another calcareous outcrop near St. Matthew's Parish in adjacent Washington county was surveyed for the presence of *A. navasotensis*, but was found to support only *A. heterophylla*.

THE FUTURE OF *AGALINIS NAVASOTENSIS*

Because *Agalinis navasotensis* is known from only one population of fewer than 300 individuals, it should be thought of as threatened, if not endangered. While the outcrop is on private land and there are no known plans to put the site into cultivation or to institute grazing, a widening of FM 3090 would probably mean the extirpation of the entire main subpopulation. The main site is not currently fenced or railed to protect it from foot or vehicular traffic.

The Oakville formation extends all the way to the southwestern corner of Duval County, and other outcrops are known along its length (Keeney 1967). It is possible, therefore, that other populations of this plant exist. It is the recommendation of the authors that any other outcrops on the formation be surveyed for the presence of *A. navasotensis*. Should many more individuals not be found, the species should be considered for inclusion on Federal and State endangered species lists.

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APPENDIX 1.

Key to the narrow-leaved, long-pediceled species of Texas *Agalinis* and members of subsect. *Pedunculares*

1. Plants perennial, stiffly erect and multistemmed from a crown of lignescent taproots; plants of gypsum outcrops in Nuevo León, Mexico .... 1. *A. gypsophila* B.L. Turner
1. Plants annual, with a single main stem branched above; roots fibrous; plants of sandy soils in central and southeastern U.S.A 2
   2. Stems and leaves succulent and fleshy, often much branched near the base and with elongate racemes above; plants of salt marshes and coastal dunes ..... 2. *A. maritima* (Raf.) Raf.
2. Stems and leaves not succulent or fleshy; more uniformly branched along the main stem; plants of non-saline habitats 3
   3. Plants yellowish green, not tending to blacken on drying; corolla often drying pale pink to white, with a band of hairs within below the adaxial calyx lobes; seeds yellow and shallowly reticulate 4
      4. Leaves triangular-subulate to linear-subulate, heavily silicified, mostly less than 1 cm long; calyx lobes triangular-subulate, 0.4–0.6 mm long ..... 3. *A. oligophylla* Pennell
      4. Leaves linear, sparingly silicified, 1.5–3 cm long; calyx lobes triangular lanceolate, (0.5)1–2 mm long 5
         5. Corolla (10)12–20 mm long, broadly campanulate, the abaxial lobes pilose on the exterior surfaces; leaves spreading; capsule globose to globose-ovoid ..... 4. *A. gattingeri* (Small) Small
         5. Corolla 7–14 mm long, narrowly campanulate, the abaxial lobes glabrous; leaves erect-ascending; capsule obovoid .... 5. *A. viridis* (Small) Pennell
   3. Plants relatively dark green, often turning black on drying; corolla pink to rose-purple, pubescent within in a narrow longitudinal line below the sinus between the adaxial lobes or this absent; seeds brown and deeply reticulate 6
      6. Fruiting pedicels exceeded by subtending bracts; calyx lobes triangular-lanceolate to lanceolate; capsule 7–11 mm long, oblong to ovoid-oblong ..... 6. *A. aspera* (Benth.) Britton
      6. Fruiting pedicels nearly to greatly exceeding the subtending bracts; calyx lobes triangular, subulate to filiform-acuminate; capsule 4–8 mm long, globose to globose-ovoid (ovoid to ovoid or oblong in *A. navasotensis*) 7
         7. Axillary fascicles of short leafy shoots well-developed; stem ridges and sides conspicuously scabrous-scabrellous throughout 8
            8. Calyx and capsules glaucous; corolla lobes subequal, spreading-reflexed; leaves narrowly linear, acute ..... 7. *A. pulchella* Pennell
            8. Calyx and capsules without whitish bloom; adaxial corolla lobes shorter than abaxial lobes and projected flatly forward; leaves linear, acuminate ..... 8. *A. homalantha* Pennell
         7. Axillary fascicles absent or few and short; stem glabrous or nearly so 9
            9. Adaxial corolla lobes arched forward over style and stamens 10
               10. Corolla essentially glabrous externally except for small patches of hairs at sinuses of lobes; calyx tube greater than 3.5 mm long; anthers 3 mm long or longer ..... 9. *A. edwardsiana* Pennell
               10. Corolla throat pilose; calyx tube less than 3.5 mm long; anthers 2.5 mm long or shorter ..... 10. *A. tenuifolia* (Vahl) Raf.
            9. Adaxial corolla lobes spreading or reflexed 11

11. Largest leaves narrowly to broadly linear, flat; most pedicels conspicuously longer than the bracts; calyx ribbed along the major veins; corolla strongly upcurved 12
    12. Flowering pedicels generally less than 2 cm long, upcurved; calyx lobes with a minute silicified tip, the tube not silicified; leaves of short tertiary and quaternary branches conspicuously shorter than those of primary and large secondary branches; inflorescences often secund ..... 11. *A. strictifolia* (Benth.) Pennell
    12. Flowering pedicels 2 to more than 5 cm long, erect to spreading; calyx lobes heavily silicified, the tube often with silicified patches; leaves of higher order branches similar to those of primary and secondary branches; inflorescences not secund ..... 12. *A. peduncularis* (Benth.) Pennell
11. Largest leaves filiform, grooved on the upper surface; pedicels about equal to or slightly longer than the bracts; calyx not ribbed; corolla slightly upcurved 13
    13. Corolla 2 to 3 cm long, lobes subequal; calyx hemispheric-campanulate; inflorescence racemose; stigma white; plants of oak woods ..... 13. *A. caddoensis* Pennell
    13. Corolla 1.3 to 2.7 cm long, adaxial lobes slightly shorter; calyx obconic; inflorescence racemose-paniculate; stigma bright greenish-yellow; plants of sandstone outcrops ..... 14. *A. navasotensis* Dubrule & Canne-Hilliker

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COMMELINA SOCORROGONZALEZIAE (COMMELINACEAE) UNA NUEVA ESPECIE DEL CENTRO-NORTE DE MÉXICO

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ABSTRACT

Commelina socorrogonzaleziae Espejo & López-Ferrari (Commelinaceae) is described from México as new to science, commentaries are made about the genus *Commelina* in México. The new species is distinguished by its flowers "flesh" colour, its linear to linear-filiform leaves and its subaquatic habit.

RESUMEN

Se describe *Commelina socorrogonzaleziae* Espejo & López-Ferrari (Commelinaceae) como nueva para la ciencia a partir de material procedente del Centro-Norte de México y se hacen comentarios acerca del género *Commelina* en México. La nueva especie se distingue por sus flores color "carne," sus hojas lineares a linear-filiformes y su hábito subacuático.

En una salida al campo al Estado de Durango con el fin de recolectar material para el proyecto Flora de México, encontramos una planta del género *Commelina* que en principio parecía una forma de *C. scabra* Bentham. Un análisis cuidadoso del material así como la revisión de especímenes de *Commelina* en los herbarios UAMIZ, IEB, ENCB y MEXU nos llevó a concluir que en realidad se trata de una especie no descrita, por lo cual proponemos:

Commelina socorrogonzaleziae Espejo & López-Ferrari, sp. nov. (subgenus *Commelina*) (Figura 1)

Herba erecta, usque 30 cm alta. Folia linear vel linear-filiforme, glabra. Spathae ovatae, conduplicatae, longissime acuminatae vel acutae, leviter falcatae, glabrae, ad basim ciliatae. Flores incarnatis, ca. 2 cm diam.

Hierba erecta, perenne, generalmente ramificada, de (7)15–30 cm de alto. Raíces fasciculado-tuberosas, numerosas, de ca. 4 cm de largo por ca. 5 mm de diámetro. Tallos delgados, cilíndricos, verdes con líneas guindas a todo lo largo, glabros a esparcidamente pubescentes. Hojas con la lámina erecta, linear a linear filiforme, de 3.5–18 cm de largo por 1–3 (hasta 4–5 en la base) mm de ancho, verde, glabra en ambas superficies, enrollada sobre si misma, la vaina algo inflada,

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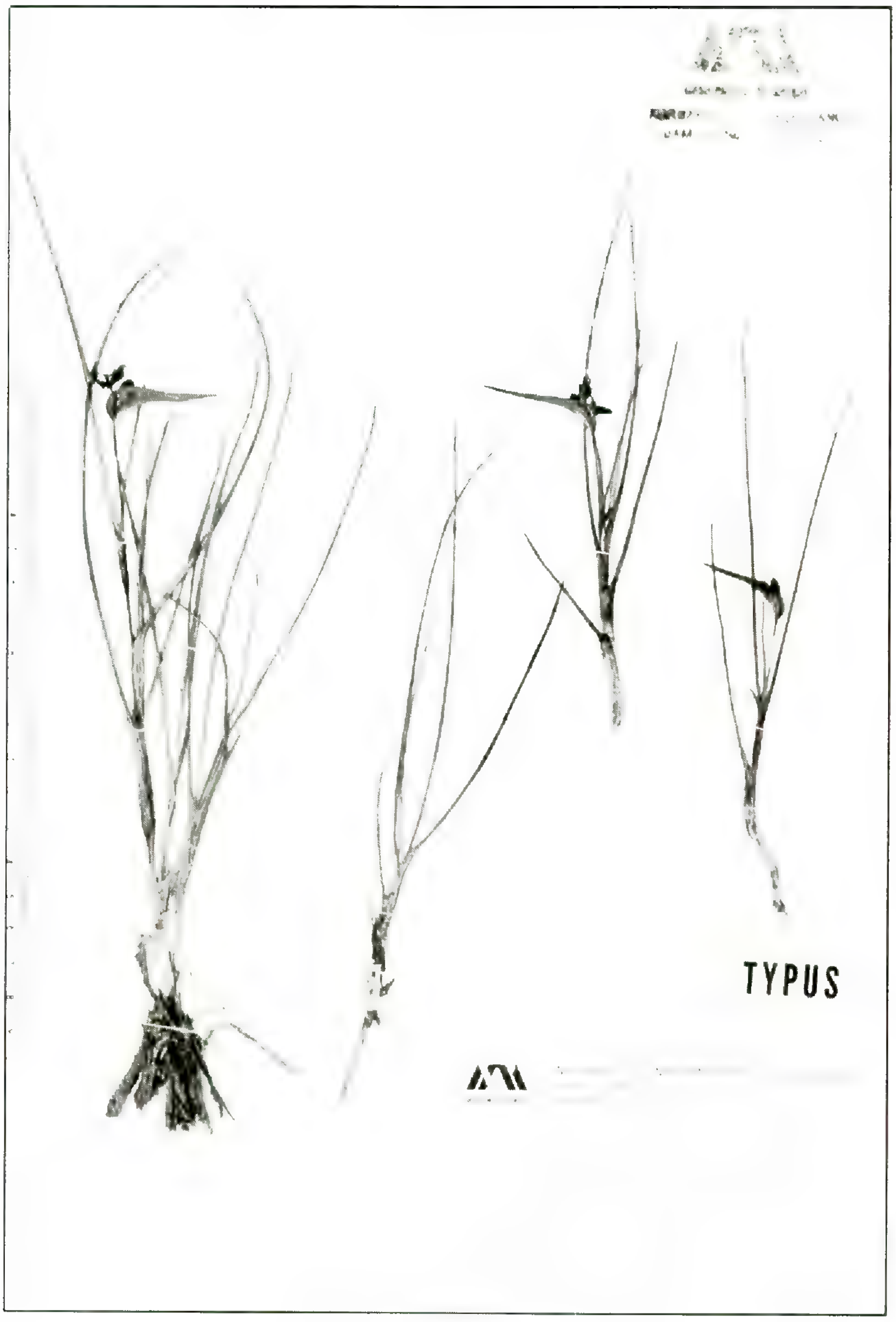

FIG. 1. Fotografía del Holotipo de *Commelina socorrogonzaleziae* Espejo & López-Ferrari.

cerrada, oblonga, de 1–3 cm de largo por 3–5 mm de ancho, blanquecina con los nervios purpúreos, glabra, ciliada hacia el ápice. Inflorescencias opuestas a las hojas superiores, el pedúnculo filiforme, glabro, excepto por una hilera longitudinal de pelos blanquecinos que se vuelven más largos y abundantes hacia el ápice, de 4–9.5 cm de largo. Bráctea espatácea conduplicada, abierta, largamente acuminada, ocasionalmente aguda, levemente falcada, de 1.5–3.5 cm de largo por

0.5–1 cm de lato, glabra excepto por algunos cilios cerca de la base, largamente ovada u ocasionalmente ovada cuando aplanada, con los nervios purpúreos marcados hacia la base. Cincino inferior con 2–8 flores, éstas abriendo consecutivamente, cubierto totalmente por la bráctea espatácea. Cincino superior vestigial o ausente, muy raramente presente (sólo una inflorescencia de todas las revisadas lo presentaba) y entonces con 4 flores. Pedicelos de ca. 2 mm de largo. Flores zigomorfas, de ca. 2 cm de diámetro, sépalos 3, verdes, glabros, el posterior triangular-ovado, de ca. 4 mm de largo por ca. 2 mm de ancho, los dos anteriores oblongos, algo cóncavos, de 4–5 mm de largo por 2.5–3 mm de ancho, algo teñidos con guinda; pétalos 3, de color carne (179-D, RHS colour chart), unguiculados, el anterior ligeramente más grande, ovado, cordado en la base, de 8–9 mm de largo por 6–8 mm de ancho, el margen ondulado, la uña de ca. 1 mm de largo por ca. 1.5 mm de ancho; los dos posteriores de forma irregular, tendiendo a triangulares o rómbicos, de 4–7 mm de largo por 3–5 mm de ancho, el margen plegado; estambres 6, los filamentos filiformes, ligeramente subulados, de color guinda, de 2–5 mm de largo, los 3 estambres superiores transformados en estaminodios y con las anteras cruciformes, amarillas, de ca. 1 mm de diámetro, los 3 inferiores fértiles, los 2 laterales isomórficos, con las anteras sagitadas, amarillas, basifijas, de 1–2 mm de largo, el del centro anisomórfico, con la antera provista en la base de un par de procesos alargados, amarilla, basifija, de 1.5–2.5 mm de largo; ovario oblongo, verde, glabro, de 6 mm de largo; estilo linear, incurvado, color guinda, de ca. 5 mm de largo. Cápsulas ovoides, con 3 ligeros ángulos, de 5–6 mm de largo por 3 mm de ancho, biloculares. Semillas (3)4 por fruto, trapezoidales, de 1.5–2.5 mm de largo por ca. 1 mm de ancho, pardas, irregularmente veteadas con blanco grisáceo, irregularmente rugosas.

Tipo: MÉXICO. Durango: **Mpio. El Salto,** llanos inundables 2 km después de Coyotes, sobre la desviación a San Miguel de Cruces, 2420 m snm, 28 Jul 1991, *M. Flores C., A. Espejo* y *A.R. López-Ferrari 502* (holotipo: UAMIZ 30232; isotipos: BRIT, CIDIIR, ENCB, IEB, K).

Paratipos: MÉXICO. Chihuahua: **Mpio. Bocoyna,** E of Gonogochic, in llano in pine-oak forest, ca. 2225 m snm, near *Allium* site 4; fls. madder color; anthers yellow; filaments madder-color, 13 Ago 1977, *R. Bye 7979* (MEXU 252920). **Durango: Mpio. El Salto,** route 40 near km 1059, ca. 5 km NE of El Salto, growing in small stream with *Gratiola*; pine woods and wet llanos with *Eryngium*, *Castilleja*, *Commelina*, *Ranunuculus*, *Calochortus* and *Lobelia*, ca. 2780 m snm, 6 Ago 1966, flowers brown, *R.W. Cruden 1162* (MEXU 133189); flats with standing water near Estación Coyotes, 2600 m snm, 13 Ago 1974, flowers pale maroon, *D.E. Breedlove 36483* (MEXU 283673). **Michoacán: Mpio. Zinapécuaro,** 1 km de la desviación a Jeráhuaro, charcos temporales, flores color carne, 2500 m snm, 21 Ago 1991, *H. Díaz Barriga et al. 6818* (IEB, UAMIZ 31250). **Querétaro: Mpio. Amealco,** laguneta al borde de la carretera aproximadamente 16 km al W de Amealco rumbo a Acámbaro, creciendo en el borde de la laguneta, enraizada a 10 cm de profundidad, flor morada, fruto verde, 11 Ago 1990, *A. Novelo y M.A. Mijangos 953* (MEXU 546220); cerca de Quiotillos, charco poco profundo, flor de color café rojizo, 2200 m snm, 18 Jul 1989, *J. Rzedowski 48592* (IEB); cerca de San Bartolo, 8 km al E de Amealco, sobre la carretera a Aculco, orilla de un estanque natural, flor de color café rojizo, 2600 m snm, 15 Ago 1989, *J. Rzedowski 48598* (IEB, UAMIZ 30233); 10 km de Amealco, sobre la carretera a San Juan

del Río, pastizal muy húmedo, flores de color café, 2100 m snm, 22 Jul 1987, *H. Díaz Barriga 4077* (IEB, UAMIZ 31251).

El género *Commelina* es el más grande de la familia *Commelinaceae* con entre 170 (Faden & Hunt 1991) y 250 (Tucker 1989) especies distribuidas en regiones cálido-templadas intertropicales. En México el género se encuentra representado por entre 9 (Hunt 1993) y 13 (Espejo & López-Ferrari, en preparación) especies.

Aunque no existe hasta el momento una revisión taxonómica integral del género *Commelina* para México, ni para regiones adyacentes, los tratamientos florísticos disponibles relativos al mismo son el de Matuda (1956) y el de Calderón & Rzedowski (1990). En dichas obras se citan 8 y 7 especies respectivamente. Además, existen diversos listados florísticos para algunas regiones del país, que incluyen especies del género que nos ocupa. Entre estos podemos citar el de González et al. (1991) que registra para Durango 5 especies y 1 variedad, el de Argüelles et al. (1991) que reporta para Querétaro 8 especies y 1 variedad y el de De la Cerda et al. (sin año) que cita para Aguascalientes 2 especies. Todas las especies reportadas para el país en los trabajos arriba mencionados, presentan flores de color azul a blanco, con excepción de *C. scabra* Benth., que tiene flores de "color salmón" o "color carne."

Commelina socorrogonzaleziae se distingue claramente de todas las demás especies de *Commelina* citadas para México por sus hojas lineares a filiformes en combinación con las flores de color carne de ca. 2 cm de diámetro y las brácteas espatáceas largamente acuminadas a agudas. La otra especie con flores color carne conocida para México es, como ya se señaló, *C. scabra*, la cual se caracteriza por su porte vigoroso, sus hojas lanceoladas, marcadamente onduladas en el margen y arqueadas en el ápice y por sus flores de ca. 4 cm de diámetro. Otra diferencia clara entre *C. scabra* y *C. socorrogonzaleziae* es que los individuos de la primera especie son generalmente pubescentes, sobre todo en las brácteas espatáceas, en tanto que los pertenecientes a la segunda son esencialmente glabros.

En material herborizado y debido al deterioro que sufren las flores al ser prensadas, *Commelina socorrogonzaleziae* puede confundirse con *C. dianthifolia* Delile, especie que presenta las hojas con la lámina lanceolada a linear y las espatas largamente atenuadas. Sin embargo, *C. dianthifolia* presenta flores azules o raramente blancas, de 2.8–3 cm de diámetro, claramente más grandes que las de *C. socorrogonzaleziae*, por lo que ambas especies pueden distinguirse aún en material seco, por el tamaño de sus partes florales. Además, los individuos de *C. dianthifolia* tienen un porte generalmente más robusto.

La nueva especie se conoce hasta el momento de los Estados de Chihuahua, Durango, Michoacán y Querétaro, en la República Mexicana (Figura 2). Cabe hacer notar que las localidades reportadas para los estados de Querétaro y Michoacán se encuentran ubicadas muy cerca de la frontera con Guanajuato, por lo que no sería difícil que en un futuro se encontraran reportes de la especie para dicho estado.

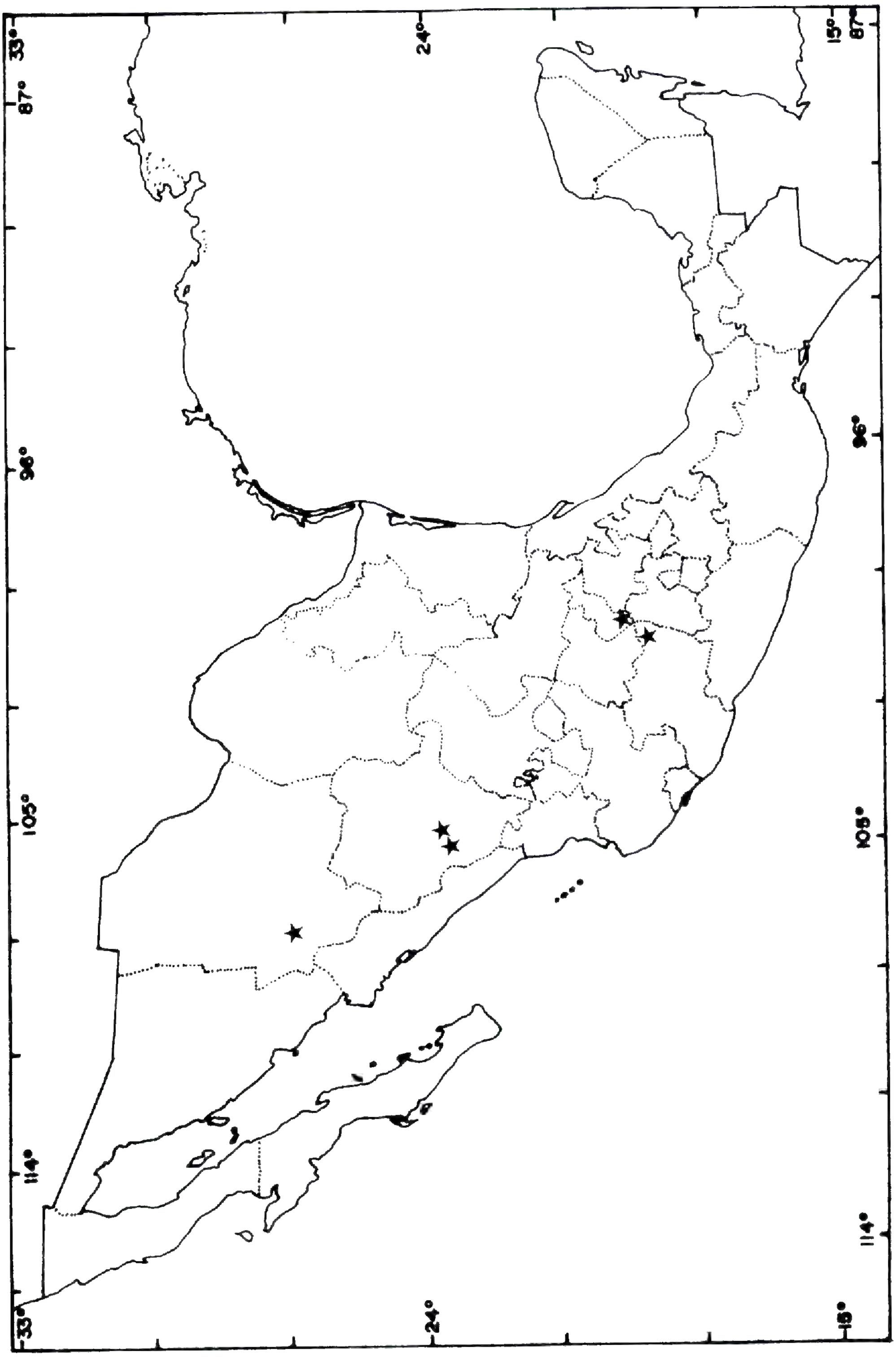

Fig. 2. Mapa que muestra la distribución conocida de *Commelina socorrogonzaleziae* Espejo & López-Ferrari.

Commelina socorrogonzaleziae habita en llanos inundables o cerca de corrientes o cuerpos de agua en lugares abiertos en bosques de pino o bosques de pino-encino entre los 2200 y los 2800 m snm. Las plantas presentan flores que abren durante la mañana, de 9–13 hrs, y solamente hay una flor en antesis por bráctea.

Dedicamos esta especie a la Dra. Socorro González Elizondo, investigadora del CIIDIR Unidad Durango, Instituto Politécnico Nacional, quién ha realizado una destacada y valiosa labor en el estudio de la flora y la vegetación del Estado de Durango.

AGRADECIMIENTOS

Queremos agradecer a los Drs. Rzedowski, su ayuda con la determinación de la especie, la revisión de la diagnosis latina, sus atinados comentarios y observaciones al manuscrito y por haber puesto incondicionalmente a nuestra disposición sus excelentes notas de campo y material herborizado de la nueva especie. La Dra. Victoria Sosa revisó el manuscrito y lo enriqueció con sus sugestiones. La Bióloga Horalia Díaz-Barriga, nos facilitó material de la nueva especie, colectado por ella, que nos permitió complementar el trabajo. El Sr. Jorge Lodigiani realizó el trabajo fotográfico.

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NOMENCLATURE OF *SETARIA* (POACEAE: PANICEAE)

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ABSTRACT

A review of the taxonomic literature of *Setaria* P. Beauv. resulted in the production of a computer database consisting of 1009 scientific names. These include 114 accepted names, 628 synonyms, 240 names of uncertain status, and 26 names currently placed in genera other than *Setaria*. Presented in hard copy is an alphabetical list of the accepted names with associated synonyms in chronological order, an alphabetical list of names placed in genera other than *Setaria*, a list of names of uncertain status in alphabetical sequence, and an index to all names. The complete database is available from the author on request.

RESUMEN

Una revisión de la bibliografía taxonómica de *Setaria* dio como resultado la elaboración de una base de datos informatizada que consite en 1009 nombres científicos. Estos encluyen 114 nombres válidos, 628 sinónimos, 240 nombres de estatus incierto, y 26 nombres que se aplican a otros géneros diferentes de *Setaria*. Se presenta una lista en orden alfabético de los nombres válidos con sus sinónimos en orden cronológico, otra lista con los nombres que se ubican en géneros diferentes a *Setaria*, otra lista en orden alfabético de los nombrees con estatus incierto y un índice con todos los nombres. Se puede obtener la base de datos completa pidiéndosela al autor.

INTRODUCTION

Setaria P. Beauv. is numerically one of the largest and most taxonomically difficult genera of the Paniceae R. Br. The species are concentrated in the tropics and subtropics where they primarily occur in open rangeland environments. An understanding of the biosystematic relationships among the taxa of *Setaria* is of academic interest and economic value to agrostology, agriculture, rangeland management, and horticulture.

The most diagnostic characteristic of the genus is the presence of sterile inflorescence branches which are commonly termed "bristles." Presence of bristles together with disarticulation at the spikelet base, texture of the upper lemma, and a muticous upper floret are characters which separate *Setaria* from other genera of the tribe (Webster 1992). When the full range of morphological variation in *Setaria* is considered, it is morphologically identical to *Paspalidium* Stapf, which includes about 30 species primarily occurring in Australia and Africa. These genera can be separated only on whether the primarily inflorescence

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branches are distichous or quaquaversal on the main axis; however, this character can be difficult to determine even for the experienced agrostologist. Morphology of the bristles, spacial relationships between the bristles and spikelets, and morphology of the spikelets are the primary characters used for the recognition of the species of *Setaria*. For the person not intimately knowledgeable about the variation of these characters, *Setaria* species can be difficult to distinguish.

Our present understanding of the morphological relationships among the *Setaria* species primarily comes from regional floristic treatments and to a lesser degree from the place of original publication. As with other numerically large and morphologically difficult genera of grasses, a comprehensive worldwide taxonomic treatment does not exist. There are two basic reasons for this shortcoming in taxonomic research. First, the taxonomist is not allow the time or does not want to invest the time to complete such a long term project. Second, funding organizations discourages such long term projects.

A taxonomic study has been initiated to produce a monographic treatment of *Setaria*. The objective of the study is to gather all morphological, anatomical, geographical, and nomenclatural data for the recognized species into one information retrieval system from which a comprehensive taxonomic account can be produced. The DELTA system (Dallwitz 1974 & 1980) is used to record descriptive taxonomic data. The character list for the Paniceae used in previous studies by Webster (1987, 1988, 1989, 1992), presently consisting of 285 characters, was used for the encoding of the descriptive data. Descriptive data for the recognized species were extracted from revisions and the principal floras of the world. Thus far, this part of the study resulted in the recognition of 114 species and the collection of 20 to 100 characters for each species. The regional floras, which are the principal source of descriptive information will always present a subset of data. Typically, much of the data presented in floras have little or no diagnostic value. At best, one can expect to find no more than 50 characters for a recognized species. Therefore, approximately 70% of the data are missing and unknown. In order of significance the following are the principal references from which the descriptive data were obtained: Webster's (1987) "The Australian Paniceae," Renvoize's (1984) "The Grasses of Bahia," Clayton & Renvoise's (1982) "Grasses in Flora of Tropical East Africa," Smith's (1982) "Flora Ilustrada Catarinense," Pohl's (1980) "Flora Costaricensis," Gould's (1979) "Poaceae in Flora of The Lesser Antilles," Gould's (1975) "The Grasses of Texas," Rosengurtt's et al. (1970) "Gramineas Uruguayas," Bosser's (1969) "Graminees Des Paturages Et Des Culture a Madagascar, Rominger's (1962) "Taxonomy of *Setaria* (Gramineae) in North America," Bor's (1960) "The Grasses of Burma, Ceylon, India, and Pakistan," Chippendall's (1955) "The Grasses and Pastures of South Africa," and Hitchcock (1927) "The Grasses of Ecuador, Peru, and Bolivia." The descriptive part of this study is incomplete since the objective is to produce a comprehensive

fully comparative database. That is, all recognized species recorded for all characters. At present, studies are underway to complete this system.

The taxonomic history of *Setaria* began in 1753 with Species Plantarum. From that date until 1812 the taxa were described in *Panicum* L., except for the work of Robert Brown who described some taxa under *Pennisetum*. From 1812 to the 1830s, Humboldt, Bonpland, and Kunth followed Palisot de Beauvois's generic concept and placed numerous names in *Setaria*. However, authors such as Nees von Esenbeck, Jean Louis Marie Poiret, and Ernst Gottlib von Steudel actively continued to describe many new names under *Panicum*. Whereas, others such as August Heinrich Grisebach placed taxa in both *Panicum* and *Setaria*. In the 1890s the nomenclature was further confused by Carl Ernst Kuntze who transferred and named many taxa under *Chamaeraphis* R. Br. and by George Nash who placed the names under *Ixophorus* Schlech. In the late 1890s and 1900s many names were placed in Frank Lamson Scribner's genus, *Chaetochloa*. Albert Hitchcock and others followed Scribner's concept until the late 1930s. During this period, botanists from South America and Asia were continuing to place new taxa in *Panicum*. By the mid 1940s, the name *Setaria* was in common use.

An essentially complete set of nomenclatural data has been collected for the sub-generic categories of *Setaria*. The specific objective of the present paper is to make available the nomenclatural data. The following nomenclatural presentation outlines the present state of knowledge concerning the names. Close examination will reveal problems which cannot be resolved until investigations are made of the European, Asian, and South American herbaria; however, it is important to present at this time the present state of knowledge concerning the nomenclature of *Setaria*.

METHODS

A detailed literature search revealed 1009 scientific names associated with the genus. In order of relative importance the nomenclatural data were primarily taken from the following references: Webster (1987), Clayton and Renvoize (1982), Gibbs-Russell (1990), Veldkamp (1980), Index Kewensis through 1989, Clayton (1979), Nicora (1978), Kerguelen (1977), Renvoize (1984), Smith et al. (1982), Koyama (1987), Pohl (1980), Gould (1979), Hsu (1978), Gould (1975), Rosengurtt et al. (1970), Bosser (1969), Chung (1965), Rominger (1962), Bor (1960), Swallen (1955), Hitchcock (1950, 1936, 1927), and Chase & Niles (1962). For example, the nomenclature presented in Clayton and Renvoise (1982) was followed over that presented in an earlier publication [eg. Pohl (1980)]. Of the 1009 names, 114 are accepted, 628 are synonyms, 26 are currently placed in genera other than *Setaria*, and 240 are placed in uncertain status. Names placed in uncertain status are those which have never been treated in a revision or floristic treatment since they were originally named. All of the

uncertain names are probably synonyms, however, examination of type material is necessary before any final decision is made.

Nomenclatural data were recorded in a Pc-File database consisting of 21 fields and is available on request from the author. The first eight fields of each record defines the scientific name of the taxon. These include the genus, specific epithet, parenthetical authority, authority, infraspecific category, infraspecific epithet, parenthetical authority, and authority of the infraspecific epithet. The ninth field contains the place of original publication, in which serial publications are abbreviated according to Botanico-Periodicum-Huntianum (1986) and others according to Taxonomic Literature (1976). The tenth field contains the year published. The eleventh field gives a literature reference for the taxonomy of the name. The twelve field gives the continent from which the type specimen was collected. The thirteenth field gives the region within the continent that the type specimen was collected. For example, a type specimen may be collected from Colombia, South America. The 14th and 15th field gives the specific collection and collection date of the type specimen. The 16th and 17th fields gives the herbarium location of the holotype and any isotypes. The 18th field gives the distribution by continent for the accepted names. The 19th field gives the present status of the name. These include "A" for accepted names, "B" for basionyms, "S" for synonyms, and "U" for names with uncertain status. Names were classified as uncertain if no reference could be found other than the place of original publication. The 20th field gives the accepted name for the basionyms and synonyms. The final field is a comment field and includes miscellaneous nomenclatural information.

As previously stated, the complete database is available on request from the author. Only a part of the information collected is presented here. The following nomenclatural data are presented in four sections. The first section consists of the accepted names in alphabetical order. Each accepted name is followed by synonyms in chronological order. The second section contains 26 synonyms whose accepted name is in a genus other than *Setaria*. The third section gives 240 names in alphabetical order that are presently classified as names of uncertain status. The final section presents an alphabetical index to all names. Accepted names are in bold face, synonyms in italic, names associated with other genera underlined, and uncertain names in standard print. Following each accepted name and synonym is a number which corresponds to the number of the accepted name in the first section. For example, *Chaetochloa ambigua* 31 indicates a synonym of the 31st accepted name which is **Setaria gussonei**.

ACCEPTED NAMES AND SYNONYMS

1. **Setaria acromelaena** (Hochst.) T. Durand & Schinz, Consp. Fl. Afric. 5:772. 1894.

Panicum acromelaenum Hochst., Flora 38:198. 1855.
Setaria abyssinica Hack. var. *annua* Chiov., Ann. Bot. (Rome) 8:311. 1907.

2. **Setaria apiculata** (Scribn. & Merr.) Schumann, Just's Bot. Jahresber. 28:417. 1902.

Chaetochloa apiculata Scribn. & Merr., Bull. U.S.D.A. Div. Agrost. 21:9. 1897.
Setaria queenslandica Domin, Biblioth. Bot. 20(85):330. 1915.

3. **Setaria appendiculata** (Hack.) Stapf, Fl. Cap. 7:422. 1899.

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Setaria hereroensis Herrm., Beitr. Biol. Pflanzen 10:43. 1910.
Setaria basifissa Peter, Fl. Deut.-Ostafr. 1, Anh.:63, fig. 32/1. 1930.
Setaria haareri Stapf & Hubbard, Fl. Trop. Afr. 9:834. 1930.

4. **Setaria arizonica** Rominger, Illinois Biol. Monogr. No. 29. 1962.

5. **Setaria atrata** Hack., Abh. Preuss. Akad. Wiss. 2:122. 1891.

Setaria blepharochaeta Chiov., Ann. Bot. (Rome) 10: 408. 1912.
Setaria pennata Peter, Fl. Deut.-Ostafr. 1:235. 1931.

6. **Setaria australiensis** (Scribn. & Merr.) Vick., Contr. New South Wales Natl. Herb. 1(6):335. 1950.

Chaetochloa australiensis Scribn. & Merr., Bull. U.S.D.A. Div. Agrost. 21:29. 1900.

7. **Setaria barbata** (Lam.) Kunth, Revis. Gramin. 1:47. 1829.

Panicum barbatum Lam., Encycl. 1:171. 1791.
Panicum lineatum Schum., Beskr. Guin. Pl.:61. 1827.
Panicum costatum Roxb., Fl. Ind. 1:314. 1829.
Panicum rhachitrichum Hochst., Flora 27:254. 1844.
Panicum basisetum Steudel, Syn. Pl. Glum. 1:52. 1854.
Panicum rarisetum Steudel, Syn. Pl. Glum. 1:52. 1854.
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Chaetochloa barbata (Lam.) Hitchc. & Chase, Contr. U.S. Natl. Herb. 18:348. 1917.
Setaria costata Stapf ex Vanderyst, Bull. Agric. Congo Belge 10:250. 1919.
Panicum nakaianum Honda, Bot. Mag. Tokyo 37:22. 1923.
Setaria nakaiana (Honda) Ohwi, Acta Phytotax. Geobot. 4:32. 1935.

8. **Setaria barbinodis** Herrm., Beitr. Biol. Pflanzen 10:60. 1910.

Chaetochloa barbinodis (Herrm.) Hitchc., Contr. U.S. Natl. Herb. 24:480. 1927.

9. **Setaria barretoi** Boldrini, Hickenia 1(21):117. 1978.

10. **Setaria bathiei** A. Camus, Not. Syst. Mus. Hist. Nat. Paris 12:153. 1946.

11. **Setaria cernua** Kunth, Nov. Gen. Sp. 1:111. 1816.

Panicum stenothyrsum Pilg., Bot. Jahrb. Syst. 21: 710. 1898.
Chaetochloa cernua (Kunth) Hitchc., Contr. U.S. Natl. Herb. 24(8):478. 1936.

12. **Setaria chapmanii** (Vasey) Pilg., Nat. Pflanzenfam. 14e:72. 1940.

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SYNONYMS PLACED IN OTHER GENERA

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2. *Chaetochloa lutescens* (Weigel) Stuntz, Bull. U.S.D.A. Bur. Pl. Ind. Inv. Seeds 31:83. 1912. = **Pennisetum glaucum** (L.) R. Br.
3. *Chamaeraphis glauca* Kuntze, Revis. Gen. Pl. 2:767. 1891. = **Pennisetum glaucum** (L.) R. Br.
4. *Ixophorus glaucus* Nash, Bull. Torrey Bot. Club 22:423. 1895. = **Pennisetum glaucum** (L.) R. Br.
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17. *Setaria hirta* (Roth.) Kunth, Revis. Gramin. 1:47. 1829. = **Urochloa panicoides** P. Beauv.
18. *Setaria hirtella* Schultes, Mant. 2:276. 1824. = **Oplismenus setarius** (Lam.) Roemer & Schultes
19. *Setaria hochstetteri* Kunth, Ann. Sci. Nat. Bot. 5:350. 1846. = **Pennisetum** (?)
20. *Setaria latiglumis* Vasey, Bull. Torrey Bot. Club 13:229. 1886. = **Setariopsis latiglumis** (Vasey) Scribn.
21. *Setaria lutescens* (Weigel) Hubb., Rhodora 18:232. 1916. = **Pennisetum glaucum** (L.) R. Br.
22. *Setaria meyeri* Kunth, Revis. Gramin. 1:47. 1829. *Setaria* pilosa (Sw.) Kunth, Revis. Gramin. 1:47. 1829. = **Panicum pilosum** Sw.
23. *Setaria muricata* (Michx.) P. Beauv., Ess. Agrost. 41, 170, 178. 1812. = **Echinochloa crusgalli** (L.) P. Beauv.
24. *Setaria pauciseta* Vasey, Bull. Torrey Bot. Club 13:230. 1886. = **Setariopsis auriculata** (Fourn.) Scribn.
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NAMES OF UNCERTAIN STATUS

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S. lancea 33
S. lancifolia 113
S. lasiothyrsa 50
S. latifolia 43
S. latiglumis
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S. laxa var. navitatis
S. laxa 4
S. laxispica 95
S. leiantha 44
S. leiocarpa
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S. leonis 45
S. leucophylla
S. leucopila 46
S. liebmanni 47
S. liebmannii f. trichorhachis 113
S. lindenbergiana 48
S. lindiensis 37
S. longepetiolata 50
S. longiflora
S. longifolia
S. longipetiolata

S. longipila 49
S. longiseta 50
S. longissima 37
S. lutescens
S. lutescens f. longiseta 78
S. lutescens f. pallens 78
S. lutescens f. pumila 78
S. lutescens var. dura 78
S. lutescens var. flava 68
S. lutescens var. longispica
S. lutescens var. parviflora
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S. respiciens 107
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S. roemerii
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S. rottleri 107
S. rubicunda
S. rubiginosa 78
S. rudifolia 37
S. rudimentosa 95
S. rufa
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S. scalaris 95
S. scandens 87
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S. scheelei 88
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S. schraderi
S. schultzii 60
S. schweinfurthii 81
S. sciuloidea 78
S. scottii 89
S. semirugosa
S. seriata
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S. setosa 90
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S. setosa var. caudata 90
S. setosa var. interrupta
S. setosa var. leiophylla 91
S. setosa var. paractenioides
S. setosa var. scabriculmis
S. setulosa 37
S. speciosa 75
S. sphacelata 92
S. sphacelata f. hirsutior
S. sphacelata f. latifolia
S. sphacelata ssp. nodosa
S. sphacelata ssp. nodosa 94
S. sphacelata ssp. pyropea 94
S. sphacelata subsp. aquamontana 92
S. sphacelata var. aurea 93
S. sphacelata var. breviseta
S. sphacelata var. sericea 94
S. sphacelata var. sphacelata 95
S. sphacelata var. splendida 96
S. sphacelata var. stolonifera 95
S. sphacelata var. torta 97
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S. stolzii 95
S. streptobotrys 68
S. stricta
S. subcordata
S. submacrostachya
S. subsetosa 48
S. subtesselata
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S. sulcata ssp. latifolia
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S. surgens 101
S. taclanensis
S. tejucensis 68
S. tenacissima 102
S. tenax 103
S. tenella
S. tenuiseta 77
S. tenuispica 94
S. texana 104
S. teysmanni
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S. thollonii
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S. torta 97
S. transiens
S. trichorhachis 113
S. triflora
S. trinervia 93
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S. umbrosa
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S. verticillata var. multiflora
S. verticillata var. pilifera
S. verticillata var. pubescens
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BOOK NOTICES

LANGER, R. H. M. and G. D. HILL. 1991. **Agricultural Plants.** Second Edition (ISBN 0-521-40545-9, hbk; 0-521-40563-7m pbk). Cambridge University Press, 110 Midland Avenue, Port Chester, NY 10573. (914) 937-9600. No price given. 387 pp.

This book provides extensive information about more than 100 field crops and pasture plants and their economic importance of temperate and subtropical regions on a family by family basis. The opening chapter discusses the world population and crop production. Chapter 2 describes the plant structure (Plant Anatomy and Morphology). The plant families discussed are arranged in alphabetical order. The last chapter describes the physiological principles of crop growth and yield. There are 112 line drawings, an index of specific names and a subject index. This is an excellent book for students and teachers of agricultural botany.—*Krishna Puttaparthi.*

LAWLESS, JULIA. 1992. **The Encyclopedia of Essential Oils.** (ISBN 1-85230-311-5, pbk). Element Inc., 42 Broadway, Rockport, MA 01966. $14.95. 226 pp.

This encyclopedia can be used as a self-help manual on how to use aromatherapy oil at home for the treatment of common complaints. Part I of this book is divided into six chapters. Chapter 1: Historical roots; chapter 2: Aromatherapy and Medical herbalism; chapter 3: The body - Actions and Applications; chapter 4: How to use the essential oils at home; chapter 5: Creative blending: This chapter describes the habitat of aromatic plants, their chemistry and the methods of extraction; chapter 6: A guide to aromatic materials. Part II is a list of 160 essential oils arranged alphabetically. There is a glossary, references, useful addresses, botanical classification, therapeutic index and a botanical index.—*Krishna Puttaparthi.*

OGDEN, SCOTT. 1992. **Gardening Success with Difficult Soils.** (ISBN: 0-87833-741-5, pbk). Taylor Publishing Company, 1550 West Mockingbird Lane, Dallas, TX 75235. $17.95. 216 pp.

This book describes gardening on limestone, alkaline clay and caliche soils. It also describes lime loving and heat tolerant varieties of trees, shrubs, roses, annuals and perennials. Included are 81 beautiful color photographs, epilogue, source of supply, bibliography and an index.—*Krishna Puttaparthi.*

SYSTEMATIC STUDY OF THE GENUS *BAILEYA* (ASTERACEAE: HELENIEAE)

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ABSTRACT

A revisionary treatment of *Baileya* is rendered following the examination of approximately 1,800 herbarium specimens of the genus. Three species are recognized: *B. pauciradiata, B. multiradiata* and *B. pleniradiata.* Descriptions, illustrations, dot-maps, keys to species and complete synonymy are presented. The relationship of *Baileya* to its most closely related genus, *Psilostrophe,* is discussed.

RESUMEN

Se hace una revisión del género *Baileya* mediante el examen de aproximadamente 1800 pliegos de herbario. Se reconocen tres especies: *B. pauciradiata, B. multiradiata* y *B. pleniradiata*. Se ofrecen descripciones, ilustraciones, mapas de distribución, clave de especies y sinonimia completa. Se discuten las relaciones entre *Baileya* y *Psilostrophe* por ser el género más semejante.

KEY WORDS: Asteraceae, *Baileya, Psilostrophe,* taxonomy

Distributed widely in the desert Southwest, *Baileya* is a genus of annual, biennial and short-lived perennial herbs with often showy yellow blossoms that have earned at least one of its species the common name of "Desert Marigold." In reviewing Lieut. Col. William H. Emory's collections of the American Southwest, John Torrey first recognized the genus in print in 1848, which William H. Harvey and Asa Gray had previously described from Thomas Coulter's collections in California in the early 1830s (Emory 1848). The genus was dedicated to Jacob Whitman Bailey of the U.S. Military Academy, renowned for his microscopical investigations and for his research in the "Algae and especially the Diatomaceae (which he was the first to detect in a fossil state in this country)" (Harvey & Gray 1849).

At the time of Torrey's report, Harvey and Gray had already recognized, but not published, three species, which they first fully described in print in 1849: *B. pauciradiata, B. pleniradiata* and *B. multiradiata.* Gray (1884) later recognized only two species, *B. pauciradiata* and *B. multiradiata,* the latter with two varieties, var. *multiradiata* and var. *nudicaulis*. What he had called *B. pleniradiata* he renamed as *B. multiradiata*, and then reduced the larger-headed *B. multiradiata* to varietal status. Subsequent works, such as Coville's (1893), have reinstated the name *pleniradiata* at the varietal if not the specific level. *Baileya pauciradiata,* with its cymose heads and few florets, is clearly the most distinct of the three, and has

posed no subsequent problems in the taxonomic literature, while *B. pleniradiata* and *B. multiradiata* have continually provoked discussion and are, by many accounts, not readily distinguishable (Kearney & Peebles 1951; Keck 1959). Rydberg (1914) recognized the greatest number of species, six. Brown (1974) in his unpublished dissertation recognized five taxa in three species.

In this paper I have returned to Harvey and Gray's original descriptions in order to call attention to a distinctive feature that Gray himself first recognized, then later ignored. Originally, Harvey and Gray had described *B. pleniradiata* as having mucronate style branches which are lacking in the other two species (cf.

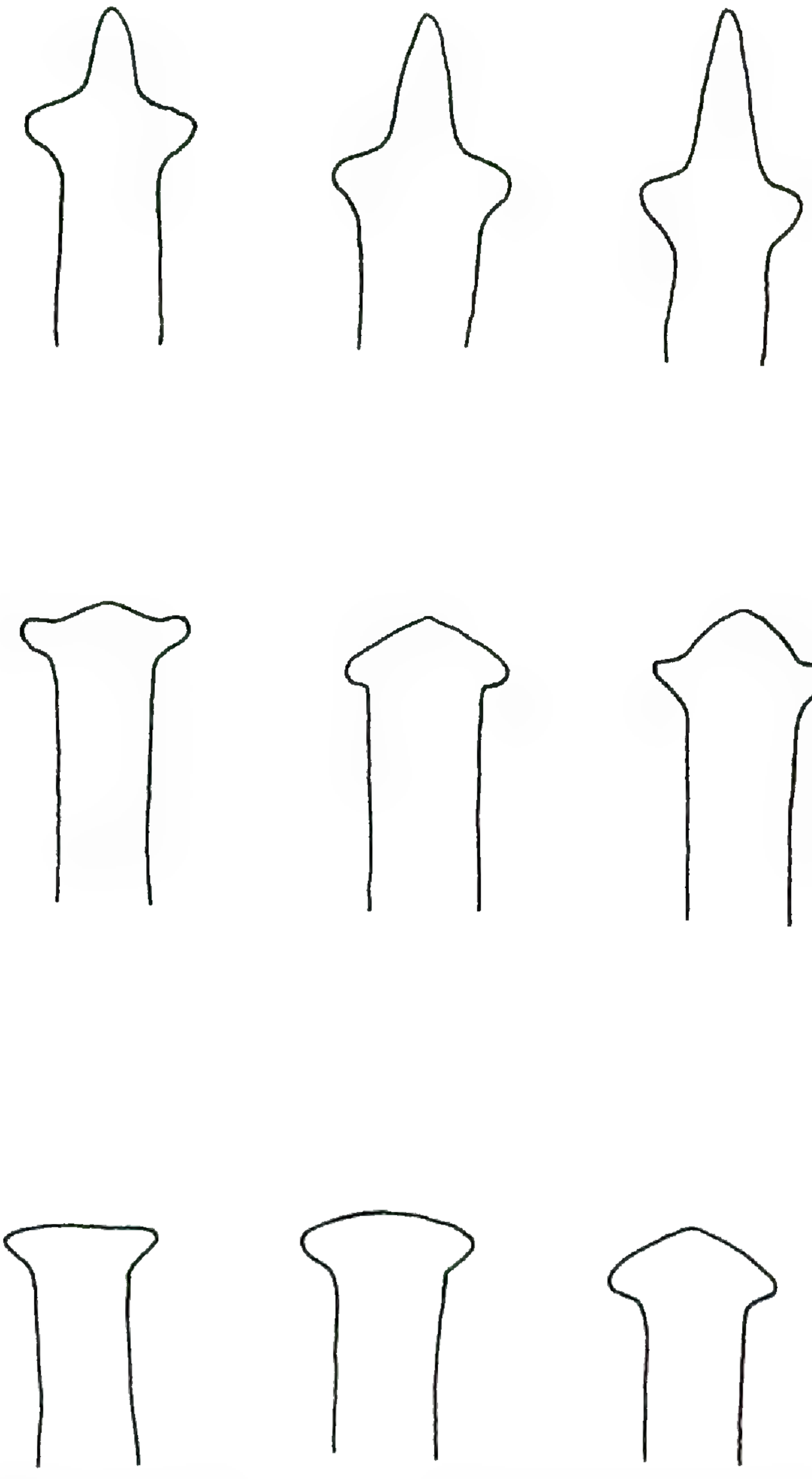

FIG. 1. Outline of style branches (top to bottom) of *Baileya pleniradiata*, *B. multiradiata*, and *B. pauciradiata*.

Fig. 1). I have found this observation—ignored in all subsequent taxonomic studies—to be a key distinguishing feature between *B. pleniradiata* and *B. multiradiata* . Although the usual distinction between these species is based on the number of ligules and on the peduncle length, these features are unreliable given the difference between the vernal and autumnal forms of *B. multiradiata.* Autumnal forms, with their smaller heads, fewer ligules and shorter peduncles, greatly resemble *B. pleniradiata,* and have caused much confusion in their identification.

In the present study three species are recognized, none of which is thought to have populational units worthy of varietal rank.

CHROMOSOMES

The first chromosome report for the genus was by Carlquist (1956) who reported a number of $2n = 32$. All subsequent workers have found chromosome numbers to be uniformly diploid with $2n = 32$ pairs, with the exception of Watson (1973) who reported a diploid count of $2n = 34$ (Table 1). The latter worker perhaps misinterpreted a pair of B chromosomes, hence the anomolous count. At least Brown and Pinkava (1974) and Brown and Thompkins (1982) have noted the presence of B chromosomes in the genus.

CHEMICAL STUDIES

Seaman (1982) in his comprehensive study of the sesquiterpene lactones of the Asteraceae has summarized most of the published material dealing with the secondary chemistry of *Baileya.* A few additional compounds are reported by Einck et al. (1978). All three species of *Baileya* have been examined for their sesquiterpene lactones with the following results:

B. multiradiata	*B. pleniradiata*	*B. pauciradiata*
baileyolin	baileyolin	
baileyin	baileyin	
fastigilin A		
fastigilin B		
fastigilin C	fastigilin C	
		hymenoratin
hymenoxon		
multigilin		
multistatin		
multiradiatin		
		odoratin
	paucin	paucin
	pleniradin	
	plenolin	
radiatin	radiatin	

Table 1: Chromosome reports for *Baileya.*

Species	Reference	Chromosome no. (2n)
B. pauciradiata	Raven & Kyhos (1961)	32
"	Pinkava et al (1972)	32
"	Strother (1976)	32
"	Keil (1981)	32
B. multiradiata	Carlquist (1956)	32
"	Raven & Kyhos (1961)	32
"	Powell & Turner (1963)	32
"	DeJong (1966)	32
"	Grashoff et al (1972)	32
"	Pinkava et al (1972)	32
"	Watson (1973)	34
"	Brown & Pinkava (1974)	32 + (0–4B)
"	Reveal & Spellenberg (1976)	32
"	Keil (1979)	32
"	Weedin & Powell (1980)	32
"	Brown & Thompkins (1982)	32 + (1–2B)
"	Strother (1983)	32
"	Ward (1984)	32
B. pleniradiata	Raven & Kyhos (1961)	32
"	Turner et al. (1961)[1]	32
"	Watson (1973)	32
"	Keil (1979)	32
"	Brown & Thompkins (1982)	32

[1]Specimen cited is from Coahuila, Mexico. From the above study, it is highly probable that this sheet represents *B. multiradiata.*

It can be seen from the above that *B. multiradiata* and *B. pleniradiata* are chemically similar based upon several shared compounds, whereas *B. pauciradiata* is relatively more remote, expressing but a couple of sesquiterpene compounds, one of these, paucin, shared with *B. pleniradiata.* All of these are C-8 lactonized helenanolids, which are relatively common in the tribe Helenieae (Seaman 1982, p. 205), although the various genera appear to sequester their own particular kinds of compounds. Thus, most of the above-listed compounds are unique to *Baileya,* but the sesquiterpene lactone, fastigilin C, also occurs in *Gaillardia fastigiata* Greene and *Hymenoxys acaulis* (Pursh) Parker, while the glucosidic derivative, paucin, has been reported from several species of *Hymenoxys.*

In addition to sesquiterpene lactones, the roots of *Baileya multiradiata* have been examined (Bohlmann et al. 1976) and found to contain a sulfoxid, a chemical type that is relatively common in the tribes Helenieae and Heliantheae.

Finally, it should be noted that K.J. Kim and B. Turner (unpubl.) have made a restriction site analysis of the chloroplast DNA of *Baileya* and closely related

genera. Their preliminary data suggest that *Baileya* nestles neatly in the tribe Helenieae somewhere near *Psilostrophe* and *Bahia,* but details of this relationship are yet to be worked out.

ECONOMIC ATTRIBUTES

Baileya multiradiata is an attractive and bountiful wild flower over a large part of the desert Southwest. It has been touted as a promising plant for landscaping, and research on its nursery production has begun (Cotter et al. 1980, 1982).

It is also reportedly toxic to livestock, especially to sheep and goats, where losses as high as 25% have been reported on overgrazed rangeland in Texas (Hill et al. 1979, 1980). Cattle and horses, however, seem to be unaffected, or at least poisoning of these animals has gone unreported. The chemical agent responsible is believed to be hymenoxon, a sesquiterpene lactone originally found in the genus *Hymenoxys,* where it is also toxic.

Both *Baileya multiradiata* and *B. pleniradiata* produce an antineoplastic pseudoguaianolide, radiatin, which might prove useful in cancer therapy (Einck et al. 1978). In addition, the antibiotic sesquiterpene lactone, baileyolin, from *B. multiradiata* inhibits tumor formation (Dominguez et al. 1977). *Baileya pauciradiata* also possesses cytotoxic sesquiterpene lactones, namely odoratin and paucin (Hoffmann et al. 1978).

Finally, it should be noted that the poorly known Desert Marigold Moth, *Schinia minima* (Grote), appears to be endemic on *Baileya multiradiata,* using the heads of this species for its larval development. Little is known about the life history of this noctuid moth, but the closely related species, *Schinia pallicincta* Smith, occupies mostly sand dunes of southern California and uses *Baileya pauciradiata* as a primary feeding source (Myles & Binder 1990).

GENERIC RELATIONSHIPS

Most recent workers have positioned *Baileya* in the tribe Helenieae, subtribe Gaillardiinae (=subtribe Heleniinae). Bentham (1873, p. 519), however, thought that *Baileya* was "nearer to some Old World *Chrysanthema* [Anthemideae] than to any American genus." Hoffmann (1894) was the first to recognize the close relationship of *Baileya* and *Psilostrophe,* positioning these two genera, along with the anomalous *Whitneya,* in the subtribe Riddellinae (after *Riddellia,* which is a synonym of the earlier *Psilostrophe*). Rydberg (1914) followed Hoffmann's treatment. Turner and Powell (1977) positioned *Baileya* and *Psilostrophe* as the only members of their subtribe Psilostrophinae, relegating *Whitneya* to or near the tribe Senecioneae.

Robinson (1981), in his comprehensive treatment of the tribe Heliantheae (including the tribe Helenieae) positioned *Baileya* (and *Psilostrophe*) in an expanded subtribe Gaillardiinae (including 13 genera). Unfortunately, he did not

attempt to relate the genera among themselves, merely listing these alphabetically.

After examination of various genera that have been suggested as closely related to *Baileya,* I conclude (as have most other workers, except Bentham, cited above) that *Psilostrophe* is closest. The comparative head and floral morphology of these two genera are illustrated in Fig. 2. As indicated in Table 2, *Baileya* and *Psilostrophe*

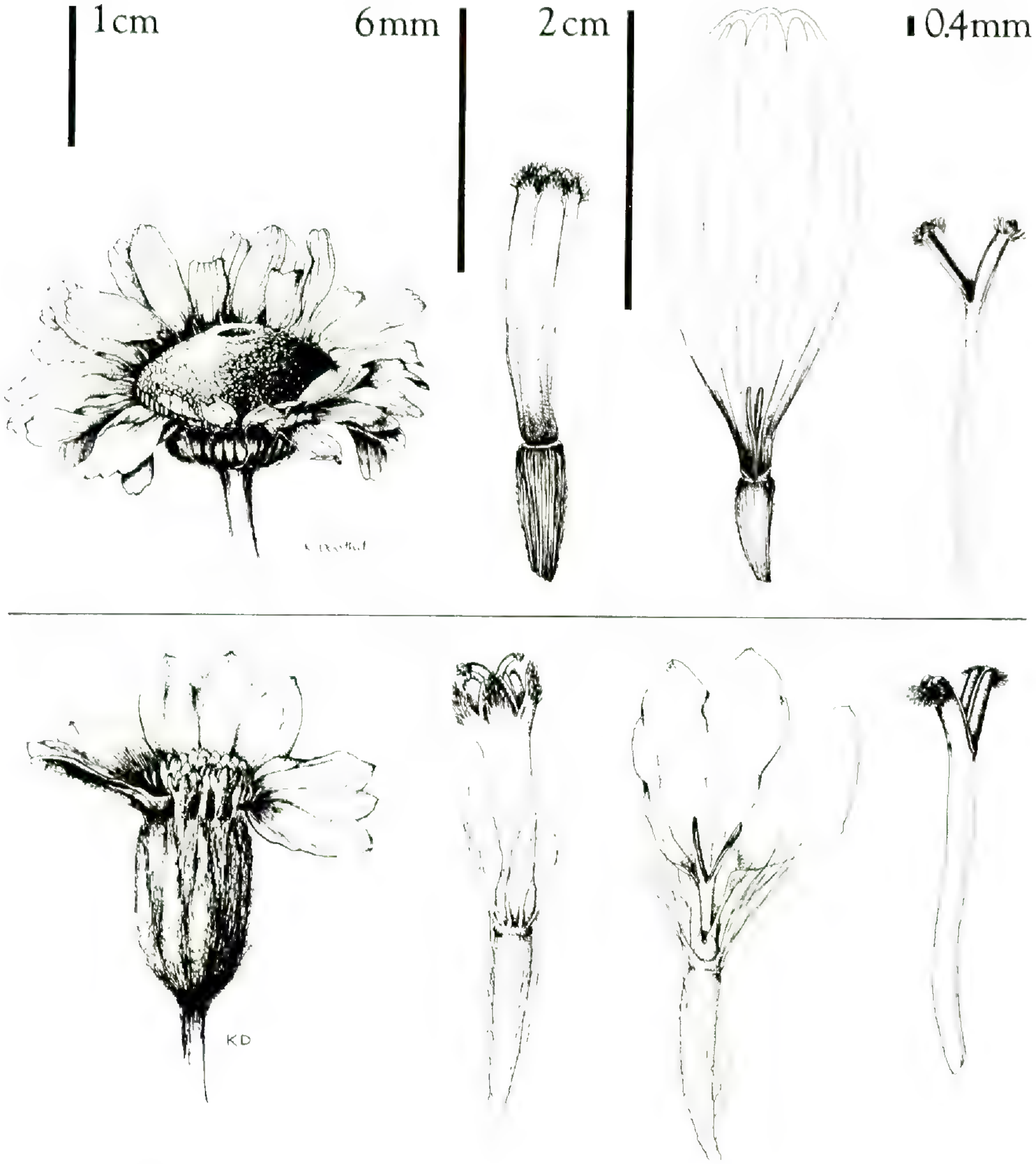

Fig. 2. Head and floral parts of *Baileya multiradiata (Warnock 13530),* upper series, and *Psilostrophe gnaphalodes (McVaugh 8224),* lower series. Left to right: heads; disk florets; ray florets; style branches (drawings by K. Douthit).

TABLE 2: Comparison of *Baileya* spp. with those of *Psilostrophe*.

B. multiradiata	*B. pleniradiata*	*B. pauciradiata*	*Psilostrophe*
1. Leaves			
mostly basal	mostly cauline	mostly cauline	mostly cauline
twice pinnatifid	once pinnatifid	simple	simple
2. Heads			
mostly single	mostly single	mostly cymose	mostly cymose
hemispheric	hemispheric	campanulate	cylindric
3. Ray florets			
30–55/head	20–40/head	5 -7/head	3–11/head
4. Disk florets			
100+/head	40–50/head	10–20/head	5–20/head
5. Style branches (Apices)			
rounded to truncate	conical	rounded to truncate	truncate
6. Pappus			
absent	absent	absent	scales

[1] Specimen cited is from Coahuila, Mexico. From the above study, it is highly probable that this sheet represents *B. multiradiata*.

share many characters especially through *B. pauciradiata,* the most distinctive species within *Baileya.* The two genera have the same base chromosome number ($x = 16$), share similar sesquiterpene lactones, and occupy similar habitats in the same region of the desert Southwest. The principal morphological difference between *Baileya* and *Psilostrophe* is that of pappus: absent in the former but composed of well-developed hyaline scales in the latter. Nevertheless, abortive scarious pappus scales occasionally occur on achenes of *Baileya pleniradiata* (cf. *Ferris 7918* TEX, *Clawson s.n.* LL), which suggests that this atavism was characteristic of *Baileya* in its primitive state.

My view of the relationships within *Baileya* to those of *Psilostrophe* are indicated in Fig. 3. Clearly *Baileya multiradiata* is most closely related to *B. pleniradiata,* the latter more nearly approaching *B. pauciradiata* through reduction of the ray and disk florets, and in having less dissected, more uniformly distributed cauline leaves. *Baileya pauciradiata* appears to link *Baileya* to *Psilostrophe* itself, which appears to be at the base of a reduction series in which the involucres, receptacles, and florets are all reduced in size, shape, and numbers, respectively. Of course, the evolutionary trend suggested here can be read, with equal validity, in the reverse: the ancestral condition being a *Psilostrophe* -like species with relatively small involucres, few florets, and evenly distributed, nearly simple leaves, the achenes with well developed pappus scales. The morphological evolution of *Baileya* from

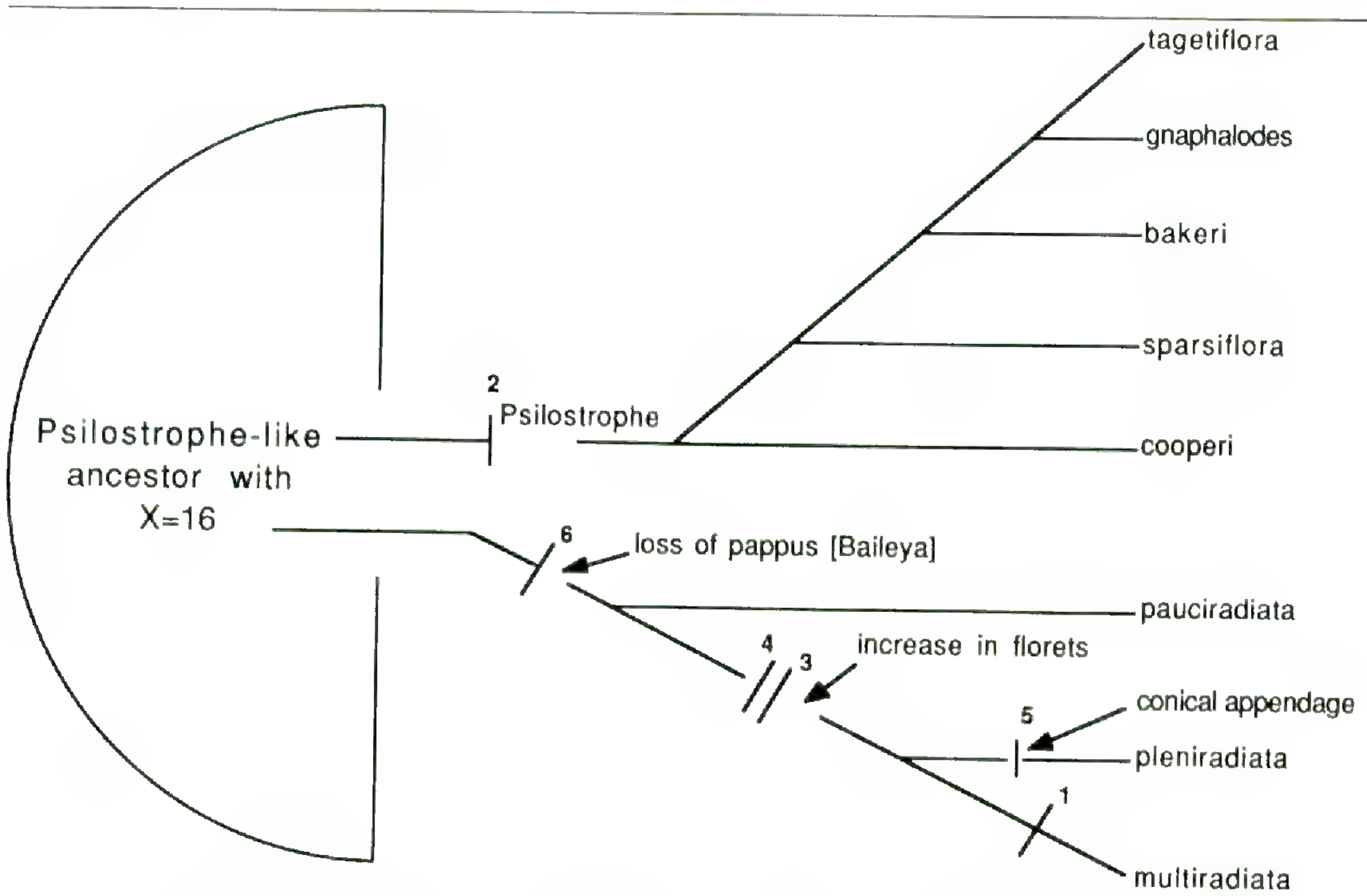

Fig. 3. Hypothetical phyletic relationships in *Baileya* and *Psilostrophe.* Numbers refer to characters given in Table 2.

this ancestral complex would merely require multiplication in floret number, increasing dissection of leaves, and loss of pappus.

Brown (1974) attempted several intergeneric crosses between *Baileya* and *Psilostrophe* without success. Unfortunately, he did not attempt an intergeneric cross with the most likely candidate for hybridization, *B. pauciradiata,* in his work.

TAXONOMY

Baileya Harvey & Gray ex Torr.

Erect, annual, biennial or short-lived perennial herbs. Stems floccose-woolly. Leaves alternate, forming a basal rosette or not; basal or rosette leaves usually petiolate; stem leaves usually epetiolate; blades simple to deeply pinnately pinnatifid, linear-lanceolate to broadly ovate in outline, pubescent like the stems. Heads radiate and solitary or cymose, usually on long peduncles. Involucres campanulate to hemispheric; bracts 2-seriate, subequal. Receptacle plane to convex, alveolate, epaleate. Ray florets pistillate, fertile, the ligules yellow. Disk florets perfect, fertile; corollas yellow, the tube shorter than the throat, the lobes 5. Anthers with ovate appendages. Style branches with truncate to acute apices.

Achenes narrowly obpyramidal, weakly ribbed or striate, epappose (rarely with a few scales).

TYPE SPECIES: *Baileya multiradiata* Harv. & Gray ex Torr.

KEY TO THE SPECIES OF *BAILEYA*

1. Heads loosely cymose at tips of branches; ray florets 5–7 ..... 1. *B. pauciradiata*
1. Heads mostly solitary at tips of branches; ray florets 20–55
   2. Apices of style branches truncate to slightly rounded; peduncles in vernal forms 10–30 cm long ..... 2. *B. multiradiata*
   2. Apices of style branches acute to strongly acute; peduncles 10 cm long or less ..... 3. *B. pleniradiata*

1. **Baileya pauciradiata** Harvey & A. Gray ex A. Gray, Mem. Amer. Acad. II, 4:105. 1849. TYPE: U.S.A. CALIFORNIA: 1832(?), *Thomas Coulter 312* (HOLOTYPE: GH!; ISOTYPE: NY!). *Coulter* reportedly collected in the area of Yuma, Arizona during 1832 (McVaugh 1943).

Winter annual, biennial or short-lived perennial, mostly 20–75 cm high. Basal rosette, if present, not persistent; basal leaves mostly 5–12 cm long, 0.5–1.0 cm wide; petioles often indistinct; blades entire to pinnately lobed, linear-oblanceolate to oblanceolate in outline. Stem leaves mostly entire and linear and often not reduced upwards. Heads cymose, on peduncles 2–5 cm long. Involucres campanulate, mostly 5–8 mm high, about as wide, floccose tomentose, the bracts mostly 8–13. Ray florets mostly 5–7; ligules elliptic to ovate, mostly 5–8 mm long, 4–6 mm wide, shallowly to indistinctly 3-toothed at apex. Disk florets mostly 10–20; corollas yellow, pubescent, 2.5–3.0 mm long, the tube ca 0.4 mm long, the lobes pubescent, ca 0.25 mm long. Style branches truncate. Achenes ca 3 mm long, multi-striate, glandular-pubescent. Chromosome number, $2n = 32$.

General range: Southwestern Arizona (Yuma Co.), southeastern California (Mojave and Colorado deserts), and adjacent Sonora and Baja California (Figs. 4, 5).

Habitat: dry, sandy deserts; elevation mostly 60–660 m.

Flowering: March to May.

The most distinct of the three species, *B. pauciradiata* has the most limited range and is, perhaps, the least abundant. It has been found growing with or near *B. pleniradiata* : 10.4 mi NE of Peñasco, Sonora, 27 Feb 1958, *Raven 11681* (GH). However, no evidence of hybrids has been noted. Brown (1974) supported the genetic isolation of the species from the other taxa by demonstrating complete barriers to gene exchange. He maintained that "all interspecific crossing attempts with *B. pauciradiata* were unsuccessful."

Representative Specimens: **UNITED STATES.** ARIZONA. **Yuma Co.:** 9 mi NE of Mohawk, 2 Apr 1973, *Holmgren 6636* (NY). CALIFORNIA. **Imperial Co.:** 20 mi E of Brawley, 25 Mar 1973, *Holmgren 6520* (NY). **Riverside Co.:** 5.6 mi SE of Thousand Palms, 18 Apr 1955, *Ingram, Arnott, Chisaki 631* (ARIZ, RM, RSA). **San Bernadino Co.:** 3 mi SW of Kelso, 1 May 1941, *Wolf 10245*

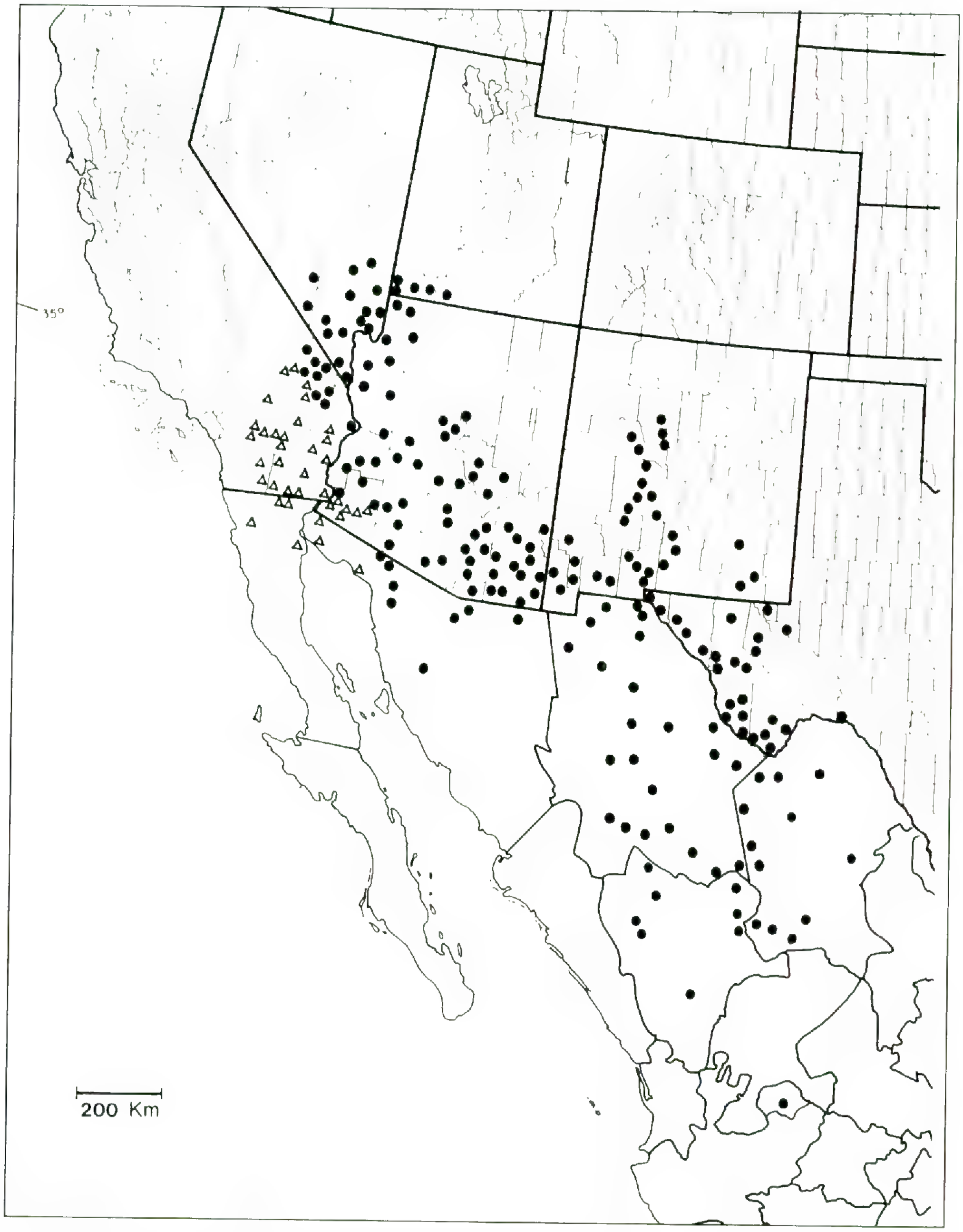

Fig. 4. Documented distribution of *Baileya multiradiata* (dots) and *B. pauciradiata* (triangles).

(LL, NY, RSA). **San Diego Co.:** Borrego Springs, 24 Apr 1976, *Moldenke 30646* (ARIZ, LL).

MEXICO. Baja California: Sierra de Juarez, E of Laguna Salada, 13 Mar 1988, *Charton 1393* (TEX, RSA); 15 mi W of Mexicali, 16 Mar 1960, *Wiggins 15737* (ARIZ, TEX). **Sonora:** 0.5 mi E of El Golfo de Santa Clara, 13 Mar 1975, *Felger 75-81* (ARIZ); 12.3 mi N of Puerto Peñasco, 21 Dec 1961, *Breedlove 1393* (TEX).

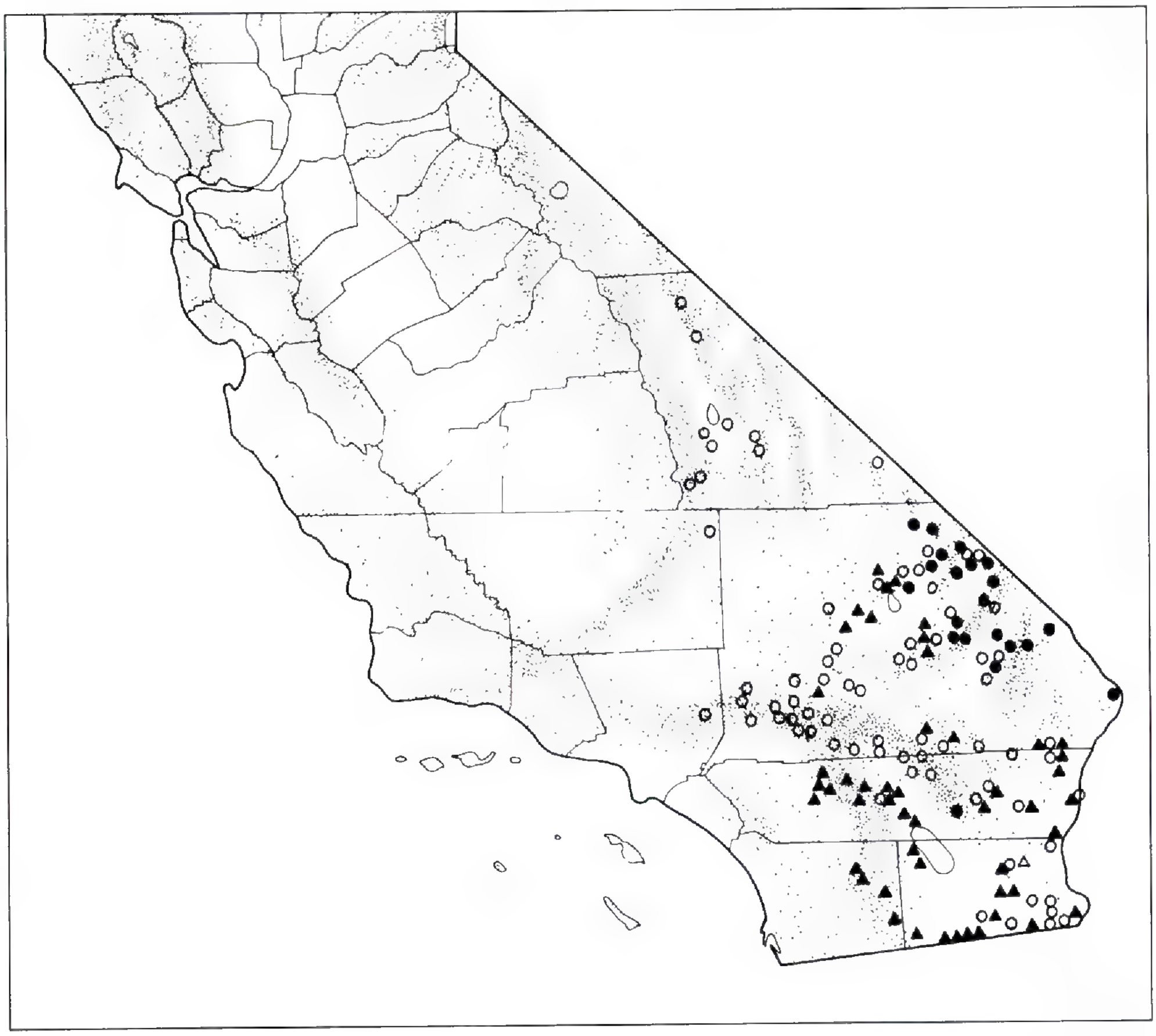

Fig. 5. Documented distribution of *Baileya* in California: *B. multiradiata* (closed circles); *B. pauciradiata* (triangles); *B. pleniradiata* (open circles).

2. **Baileya multiradiata** Harvey & A. Gray ex Torr., In Emory, Not. Milit. Reconn. 144. 1848. TYPE: U.S.A. CALIFORNIA: 1832(?), *Thomas Coulter 326* (LECTOTYPE: GH!). Originally lectotypified by Roy Brown, Jun 1973, but formalized here in accordance with the International Code of Botanical Nomenclature (ICBN). *Baileya pleniradiata* var. *multiradiata* (Harvey & A. Gray) Kearney, Trans. New York Acad. Sci. 14:42. 1894.

Baileya multiradiata var. *nudicaulis* A. Gray, Syn. Fl. N. Amer. 1(2):318. 1884. TYPE: U.S.A. NEW MEXICO: Oct 1846, *Wislizenus 7* (LECTOTYPE: GH!; ISOLECTOTYPE: NY!). Lectotypified here; collection data obtained from isolectotype, NY.

Baileya thurberi Rydb., N. Amer. Fl. 34:10. 1914. TYPE: U.S.A. TEXAS: "along the Pecos [River]," Nov 1850, *Thurber 132* (HOLOTYPE: NY!; ISOTYPES: GH!, NY!). *Baileya multiradiata* var. *thurberi* (Rydb.) Kittell, Fl. Arizona & N. Mex., 457. 1941.

Baileya australis Rydb., N. Amer. Fl. 34:11. 1914. TYPE: MEXICO. DURANGO: Santiago Papasquiaro, Apr–Aug 1896, *Palmer 50* (HOLOTYPE: NY!; ISOTYPES: GH!, POM!).

Winter annual, biennial or short-lived perennial, mostly 20–100 cm high. Basal (rosette) leaves mostly 3–10 cm long, 1–5 cm wide; petioles 1–4 cm long; blades pedately to pinnately parted, ovate in outline, rarely not. Stem leaves in vernal forms much reduced; autumnal forms often leafy throughout and stem leaves not much reduced. Heads solitary, on peduncles 10–30 cm long (vernal forms), often less on autumnal forms. Involucres hemispheric (vernal forms), mostly 5–10 mm high, 10–25 mm wide, floccose tomentose, the bracts mostly 21–34. Ray florets (vernal forms) mostly 34–55; ligules linear-oblanceolate, mostly 10–20 mm long, ca 5 mm wide, moderately to deeply 3-toothed at apex. Disk florets (vernal forms) 100+; corollas yellow, pubescent, ca 4 mm long, the tube ca 1 mm long, the lobes pubescent, ca 0.25 mm long. Style branches with truncate to slightly rounded apices. Achenes ca 4 mm long, multistriate, glandular-pubescent. Chromosome number, $2n = 32$.

General range: from California (San Bernadino Co.) to western Texas; from southwestern Utah and southern Nevada south to Mexico as far as Aguascalientes (Figs. 4, 5).

Habitat: very common on both stony slopes and sandy plains and mesas; elevation mostly 100–2,000 m.

Flowering: primarily March to November, depending on rains.

Baileya multiradiata has by far the widest range and is the most abundant and usually the earliest blooming of the three species. The large-headed vernal form is particularly attractive; this, together with its long flowering season and its drought tolerance, have given the plant recognition in horticultural circles where it is usually known as the Desert Marigold. The autumnal blossoms greatly resemble *B. pleniradiata* both in the number of rays and in the length of peduncles, which has caused much confusion in the distinction between these two species. The shape of the style apex (Fig. 1) is often necessary to distinguish between fall-blooming specimens.

Rydberg's *B. australis* appears to be merely a very robust form of *B. multiradiata* and I could find no truly distinct feature that would justify its status as a populational entity, although Brown (1974) recognized it at the varietal level (unpublished), emphasizing its supposedly "sparsely leafy" stems and weakly-ribbed, glabrous achenes. I could find no correlation between these characters, singly or in combination, that would align with geography. Robust forms occur sporadically throughout the southern range of *B. multiradiata.*

Brown likewise recognized var. *thurberi* on the basis of leafy stems arising from a perennial base, which, he maintained, distinguished it from var. *multiradiata* which had principally basal leaves and presumably was not perennial. In my opinion var. *thurberi* in its typical form is merely a perennating or autumnal form of a highly variable *B. multiradiata* and does not correlate with geography in any way. *McVaugh 7793* (TEX) and *Correll 32203* (LL), for instance, clearly evince the characters of Brown's var. *multiradiata*, but were found in Brewster Co., Texas,

several hundred miles southeast of the range that Brown gives to this variety and well within the range of his concept of var. *thurberi.* It is noteworthy that Brown apparently did not do field work in the eastern part of the range of *B. multiradiata,* at least to judge from specimens cited from his dissertation. While Brown admitted to a degree of intergradation between the two varieties, I am suggesting that his var. *thurberi* is merely a perennating form of *B. multiradiata* and that such forms occur throughout the range of the species, as I have repeatedly noted in the field.

Carl B. Wolf noted on the label of his *B. multiradiata* (*7000* NY): "This species seems to be restricted to stony slopes, while *B. pleniradiata* prefers the fine soil of the flats. There is no mixing in this region either in distribution or characters." Cronquist's herbarium labels on specimens at NY also note that the two species show no mixing of morphological characters from sympatric populations in southern Nevada. With regard to hybridization, Brown (1974) demonstrated that the two species, *B. multiradiata* and *B. pleniradiata,* are highly interfertile in synthetic crosses, though he also noted the partial infertility of the F1 hybrids.

Representative specimens: UNITED STATES. ARIZONA. **Cochise Co.:** 10 mi NE of Douglas, 19 Jun 1930, *Goodman & Hitchcock 1230* (GH, LL, NY, RM). **Coconino Co.:** near Sedona, 27 Apr 1963, *Beach s.n.* (RSA). **Gila Co.:** Sierra Ancha Mts, 4 Sep 1946, *Gould & Hudson 3870* (ARIZ, LL). **Graham Co.:** 12 mi S of Gernonimo, 27 Apr 1969, *Douglas 75* (ARIZ). **Greenlee Co.:** near Clifton, 1 Nov 1880, *Greene s.n.* (NY). **Maricopa Co.:** 4 mi S of Salt River on Jackrabbit-Rainbow Valley Rd, Apr 1973, *Sundell 269* (ARIZ). **Mohave Co.:** 9 mi E of Kingman, 17 Jun 1965, *Crutchfield 237* (LL, NY). **Pima Co.:** 8 mi SSW of Robles Junction (Three Points), 7 Apr 1973, *Holmgren 6696* (NY, RM). **Pinal Co.:** ca 20 mi W of Casa Grande City, 22 Mar 1935, *Nelson 1264* (NY, RM). **Santa Cruz Co.:** Patagonia, 30 Mar 1916, *Hill 25895* (RM). **Yavapai Co.:** 9 mi NE of Cottonwood, 8 May 1989, *Brooks 19222* (NY, RM). **Yuma Co.:** NE of Yuma, 6 mi N of Gila River, 20 Mar 1974, *Booth A-114* (ARIZ). CALIFORNIA. **Riverside Co.:** end of Hayfield Rd, S of Hwy 10, 28 Mar 1969, *Young P430* (POM). **San Bernadino Co.:** near Bonanza King Mine, Providence Mtns, 21–24 May 1920, *Munz, Johnston & Harwood 4108* (GH, NY, POM, RM). NEVADA. **Clark Co.:** Charleston Mtns, Old Kyle Canyon, 12 May 1938, *Clokey 8175* (ARIZ, GH, LL, NY, POM, RM, TEX). **Lincoln Co.:** Meadow Valley Wash, Calientis [sic], 28 Apr 1902, *Goodding 648* (GH, POM, RM). **Nye Co.:** 1.9 mi S of Hwy 95 on Rt 16, 4 Apr 1978, *Williams 78-13* (NY). NEW MEXICO. **Bernalillo Co.:** E edge of Albuquerque, 20 May 1973, *Saufferer 185* (NY, TEX). **Chaves Co.:** 11 mi NE of Roswell, 23 Aug 1942, *Waterfall 4299* (ARIZ, GH). **Doña Ana Co.:** 2 mi S of Rincon, 9 Jun 1965, *Crutchfield 166* (LL, NY). **Eddy Co.:** 12 mi NW of Carlsbad, 13 Aug 1942, *Waterfall 3710(a)* (ARIZ, GH). **Grant Co.:** 18 mi NW of Silver City, 10 May 1903, *Metcalfe 61* (ARIZ, GH, NY, POM, RM). **Hidalgo Co.:** 5 mi S of intersection Hwy 80 and IH 10 on 80, 30 May 1967, *Mears 1594* (TEX). **Luna Co.:** ca 2 mi E of Gage, 22 Mar 1972, *Hartman 3213* (LL). **Otero Co.:** near Three Rivers, 16 Aug 1941, *Wilthank 328* (LL, RM). **Sandoval Co.:** Cañada Nervio near Las Lagunitas Ranch, 30 Jun 1970, *Bohrer 1305* (ARIZ). **Sierra Co.:** 24 mi N of Hot Springs [Truth or Consequences], 15 Oct 1948, *Dunn 5412* (TEX). **Socorro Co.:** Socorro, 27 may 1931, *Nelson 11462* (GH, RM). **Valencia Co.:** E of Old Laguna, 28 Jul 1933, *Degener 4887* (NY). TEXAS. **Brewster Co.:** ca 5 mi N of Study Butte, 14 Sep 1991, *Turner 7* (TEX). Culberson Co.: ca 8 mi S of Van Horn, 7 Aug 1945, *Lundell 7* (LL). **El Paso Co.:** 1 mi N intersection of Hwys 62 and 180, 27 Aug 1989, *Mayfield 62* (TEX). **Hudspeth Co.:** 12 mi W of Sierra Blanca, 17 Jun 1943, *Waterfall 4579* (ARIZ, NY, TEX). **Jeff Davis Co.:** 1 mi NW of Valentine, 6 Sep 1955, *Warnock 13530* (LL). **Loving Co.:** 5 mi W of Winkler-Loving

border, 10 Jul 1965, *Stuessy 177* (TEX). **Presidio Co.:** 9.3 mi S of Shafter, 24 Jul 1973, *Henrickson 11266* (LL). **Reeves Co.:** 29 mi N of Pecos, 1 Jul 1958, *Correll & Johnston 19075* (LL, NY). **Val Verde Co.:** Pecos River Canyon below high bridge, 14 Jun 1931, *Tharp 8885* (TEX). **Ward Co.:** 6 mi S of Peyote, 17 Jun 1970, *Powell 1893* (TEX). UTAH. **Kane Co.:** 10 mi NW of Kanab, 27 Apr 1968, *Valentine 27* (POM). **Washington Co.:** St. George, 22 Apr 1942, *Gould 1618* (ARIZ, GH, NY, POM).

MEXICO. Aguascalientes: 5 mi E of Aguascalientes, 9 Aug 1958, *McVaugh 16707* (NY); near Aguascalientes, 9 Oct 1903, *Rose & Painter 7748* (GH). **Chihuahua:** 2–3 mi W of Parral, 18 Aug 1967, *Stuessy 1018* (LL, NY, RM, TEX); 13 mi W of Chihuahua, 20 Aug 1939, *White 2458* (ARIZ, GH, LL). **Coahuila:** 3 m SW of Torreon, 10 Jul 1944, *Fisher 44126* (GH, NY); 3 km S of El Tule, 15 Jun 1941, *Stewart 535* (GH, LL). **Durango:** 3.5 km W of La Soledad, 19 Mar 1983, *Diaz 105* (NY, TEX); 17 km WSW of Ciudad Lerdo, 26 Jul 1982, *Diggs & Nee 3113* (NY, TEX). **Sonora:** 39 mi N of Hermosillo, 12 Sep 1941, *Wiggins & Rollins 472* (ARIZ, GH, NY); 3 mi E of Agua Prieta, 7 Aug 1941, *White 3823* (ARIZ, GH, LL).

3. Baileya pleniradiata Harvey & A. Gray ex A. Gray, Mem. Amer. Acad. II, 4:105. 1849.

TYPE: U.S.A. CALIFORNIA: 1832(?), *Thomas Coulter 312* (LECTOTYPE: TCD; Fragment LECTOTYPE: GH!). *Baileya multiradiata* var. *pleniradiata* (Harvey & A. Gray) Coville, Contr. U.S. Natl. Herb. 4:133. 1893.

Baileya nervosa M.E. Jones, Contr. W. Bot. 8:34. 1898. TYPE: U.S.A. CALIFORNIA. **Inyo. Co.:** Darwin Mesa, Argus Mountians, 5,000 ft, 11 May 1897, *Jones s.n.* (HOLOTYPE: POM!; ISOTYPE: NY!).

Baileya pleniradiata var. *perennis* A. Nels., Bot. Gaz. (Crawfordsville) 47:431. 1909. TYPE: U.S.A. NEVADA. **Clark Co.:** Moapa, 8 Apr 1905, *Goodding 2176* (HOLOTYPE: RM!; ISOTYPES: GH!, NY!). *Baileya perennis* (A. Nels.) Rydb., N. Amer. Fl. 34:10. 1914. *Baileya multiradiata* var. *perennis* (A. Nels.) Kittell, Fl. Arizona & N. Mex. 457. 1941.

The only collection of this taxon at GH is a fragment from the head which is contained within a packet bearing the Coulter collection number 312; the fragment was presumably sent to GH at the request of Gray, as the packet bears a notation that this was obtained from Dublin (TCD) where the Coulter collections are housed. Brown (Jun 1973) by annotation selected this as the lectotype (but see comments regarding ICBN above), since it was the only material of the taxon to be examined by Gray at the time of his descriptions. Examination of the several disk florets in the packet show the style branches to be acute, as to be expected in *B. pleniradiata*. Coulter's number 312, while written on the packet itself, is also the number assigned to the type of *B. pauciradiata*. Apparently, Coulter, or someone, assigned the same number to a mixed collection. Since both *B. pleniradiata* and *B. pauciradiata* occur together or near each other in southern California, it is likely that he collected both of these taxa, assigning them the same number.

Winter annual, biennial or short-lived perennial, mostly 15–45 cm high. Basal rosette, if present, not persistent; basal leaves mostly 2–7 cm long, 0.5–2.5 cm wide; petioles 1–3 cm long; blades entire to pinnately lobed, oblanceolate in outline. Stem leaves gradually reduced upwards. Heads solitary, on peduncles 3–12 cm long. Involucres hemispheric, mostly 5–8 mm high, 7–12 mm wide, floccose tomentose, the bracts mostly 21–34. Ray florets mostly 20–40; ligules

elliptic to obovate, mostly 7–10 mm long, 4–7 mm wide, shallowly 3–toothed at apex. Disk florets mostly 40–50; corollas yellow, pubescent, ca 3 mm long, the tube ca 0.3 mm long, the lobes pubescent, ca 0.25 mm long. Style branches acute. Achenes ca 3 mm long, multi-striate, glandular-pubescent. Chromosome number, $2n = 32$.

General range: Somewhat less common than *B. multiradiata* and with a much more restricted range, extending east from Los Angeles Co., California to south-central Arizona, and extending south from Inyo Co., California, southern Nevada, and southwestern Utah to northern Baja California and Sonora, Mexico (Figs. 5, 6).

Habitat: common on sandy plains and mesas; elevation mostly 100 – 2,000 m.

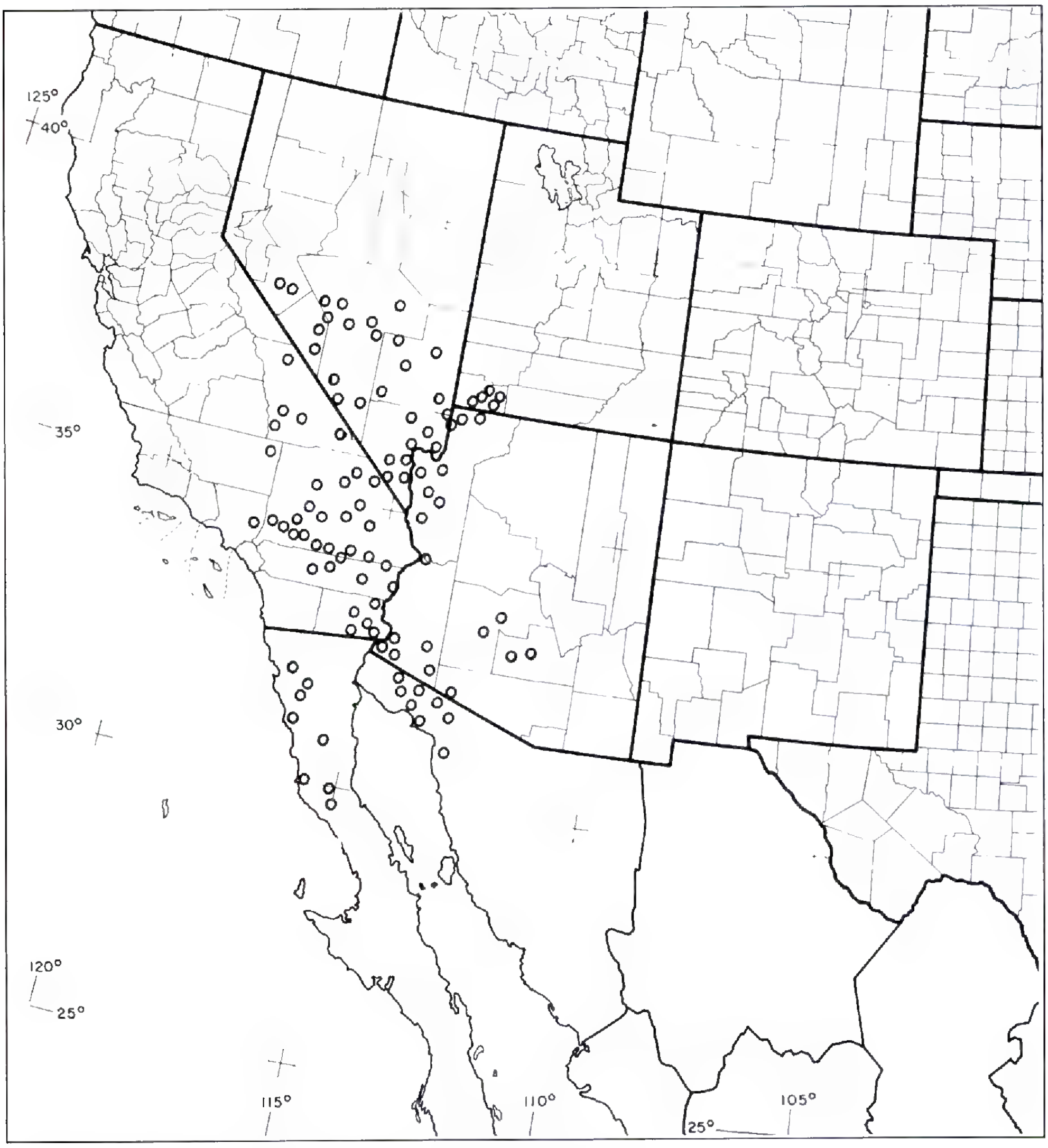

Fig. 6. Documented distribution of *Baileya pleniradiata*.

Flowering: March to November, depending on rains.

Baileya pleniradiata is superficially similar to *B. multiradiata* and autumnal forms of the latter have often been misidentified as the former, as noted under the discussion following *B. multiradiata.* The two species occasionally occur growing together or in close proximity, but hybrids have not been noted. Style appendages readily allow distinction between these (Fig. 1).

Baileya pleniradiata occasionally occurs with or near *B. pauciradiata,* at least in Mexico, to judge from the collections of *Raven 11682* (GH: 10.4 mi NE of Peñasco, Sonora). Nevertheless, natural hybrids between these have not been recorded, nor were synthetic crosses successful (Brown 1974).

Representative specimens: UNITED STATES. ARIZONA. **Maricopa Co.**: Sierra Estrella Regional Park, 29 Apr 1973, *Sundell 270* (ARIZ, NY, POM). **Mohave Co.**: Littlefield, 12 Jul 1959, *Demaree 41322* (ARIZ, NY, RSA). **Pima Co.**: Quitobaquito, 14 Apr 1963, *Felger 7681* (ARIZ). **Pinal Co.**: near Sacaton, 8 Apr 1927, *Peebles & Harrison 3874* (ARIZ, LL). **Yuma Co.**: ca 7 mi N of Dome, 24 Mar 1970, *Hitchcock 25762* (NY, RM, TEX). CALIFORNIA. **Imperial Co.**: 0.5 mi N of Hwy 80 on rd to Blythe, 20 Mar 1958, *Balls & Everett 22893* (RM, RSA). **Inyo Co.**: Darwin Mesa near Darwin, 11 Jun 1930, *Ferris 7918* (ARIZ, GH, NY, RM, RSA, TEX). **Kern Co.**: Naval Weapons Center, China Lake, 27 Apr 1969, *Brierly s.n.* (GH). **Los Angeles Co.**: 30 mi W of Victorville, 27 Apr 1926, *Mason 3064* (GH). **Riverside Co.**: 8 mi NE of Desert Center, 27 Mar 1941, *Wiggins 9684* (GH, NY, RM, RSA). **San Bernadino Co.**: 2 mi W of Valley Wells, 15 May 1935, *Wolf 6861* (ARIZ, GH, RM, RSA). NEVADA. **Clark Co.**: E of Wilson's Ranch [ca 20 mi NNW of Jean], 22 May 1940, *Clokey 8619* (ARIZ, GH, LL, NY, POM, RM, TEX). **Esmeralda Co.**: 18.3 mi NW of Goldfield, 5 May 1981, *Tiehm 6363* (NY, RM, RSA). **Lincoln Co.**: 11 mi S of Adaven, 1 Jul 1966, *Holmgren 2786* (NY, RSA, TEX). **Mineral Co.**: 5 mi W of Luning, 18 Jun 1945, *Maguire & Holmgren 25511a* (GH, NY). **Nye Co.**: 13 mi NW of Tonopah, 31 May 1980, *White & Neese 155* (NY, RM). **UTAH. Washington Co.**: ca 6 mi NW of St. George, 6 May 1964, *Conquist 9939* (NY, RSA, TEX).

MEXICO. **Baja California**: 10 mi W of El Marmol, 6 Mar 1930, *Wiggins 4376* (GH, LL, NY, POM, TEX); Valle de la Trinidad, 16 Mar 1936, *Harbison s.n.* (POM, RM, RSA). **Sonora**: ca 7 mi N of Puerto Peñasco, 25 Jun 1985, *Felger 85-784* (ARIZ, TEX); 56 km W of Sonoyta, 14 Jul 1971, *Gibson & Gibson 2016* (LL, NY, RSA).

This study is based in large part upon the examination of approximately 1,800 sheets from seven herbaria as follows: ARIZ (253), GH (259), LL (119), NY (416), POM-RSA (449), RM (162), TEX (142). I am grateful to the Directors and Curators of each for the loan of material.

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A NEW SPECIES OF *CAREX* (CYPERACEAE: TRIQUETRAE) FROM THE CHISOS MOUNTAINS, TEXAS, AND A KEY TO SPECIES OF SECTION *TRIQUETRAE*

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ABSTRACT

Carex lativena, section *Triquetrae*, is described from the Chisos Mountains in southern Brewster County, Texas. It was found in an open semi-dry hardwood-conifer forest. It differs from its putative closest relative, *C. planostachys*, in having more numerous and shorter basal peduncled pistillate spikes; shorter culms; perigynia that are conspicuously obovate, less pubescent and with shorter, abruptly bent beaks; achenes that are apically retuse, brown in color; and differing in achene micromorphology. Both species are cespitose in habit. The difference being that the cespitose clumps of *C. lativena* is composed of individual plants that can be pulled apart from each other. A key to the species of section *Triquetrae* is included.

Carex section *Triquetrae* Carey is a New World group of species found in semi-xeric to mesic habitats. This section ranges from northern Central America through North America in temperate and warmer regions (Mackenzie 1935). This section now includes six species: *C. dasycarpa* Muhlenberg, *C. hirtifolia* Mackenzie, *C. lativena* S.D. Jones & G.D. Jones, *C. planostachys* Kunze, *C. tenax* Chapman, and *C. triquetra* Boott. Section *Triquetrae* is characterized by having narrow leaf blades; bract of the lowermost non-basal spike with a well-developed blade; trigonous achenes that fill the perigynia; a short, thick style, and 3 stigmas.

The placement of *C. lativena* into section *Triquetrae* is one of convenience at this time. It is beyond the scope of this paper to realign sections. However, we do suggest that section *Triquetrae* may be polyphyletic. *Carex lativena* and its closest putative relative *C. planostachys* are likely more aligned with the Eurasian and northern African species *C. halleriana* Asso. *Carex dasycarpa*, *C. tenax*, and possibly *C. triquetra* show a close relationship to each other, but not to *C. lativena*, *C.*

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planostachys, or *C. hirtifolia*. *Carex hirtifolia* appears not to be closely related to any of the taxa presently aligned in section *Triquetrae*.

Carex lativena S.D. Jones & G.D. Jones, sp. nov. BROAD-VEIN CAREX (Fig. 1).

Plantae cespitosae; culmis fertilis 4–12 cm altis. Foliis 3–5, laminis maximam partem (5) 19–31 cm longis, (0.5–) 1.2–2.0 mm latis planis striatis; paginae adaxialae sparsim antrorse scabridiusculae, proximaliter maximam partem antrorse scabridiusculae distaliter costa impressa; paginae abaxialae glabrae, proximaliter costa elevata distaliter carinascentibus, margine minute asperato vel antrorse scabridiusculo; vaginae 1.5–5 cm longae culmos et bases pedunculorum plus minusve arcte involventibus; vaginis basales albis vel viridis pallidis striatis membranaceis minute antrorse scabridiusculis. Inflorescentiis 4–6 spicis; culmis fertilis 2–3 spicis basales pistillatis et 3 spicis terminalibus; spicis basales 2–3 pistillatis 3–4 cm longis ad basim ex culmis fertilis exorientibus; spicis terminalibus primis pistillatis 5–7 mm longis, 3–6 perigynio, deinde spicis terminalibus staminatis vel spicis gynaecandris vel spicis immixtis floribus maribus et femineis 7–8 mm longis, spicis pistillatis pedunculo 2–3 mm longo et spicis staminatis pedunculo 3–4 mm long. Squamis spicis pistillatis glabris 3.5–4.2 mm longis 1.3–2.0 mm latis; squamis staminatis glabris 4–5 longis 1.5–2.1 mm latis. Perigynio adpresso (3.0–) 3.5–3.8 (–4.0) mm longo (1.1–) 1.4–1.9 (2.1) mm lato, trigono, faciebus duobus apicalis convexis atque facie laterali plani vel leviter concavi, plerumque stramineo aliquam pallidi viridi, plerumque glabro sed sparsim hispidulo apicaliter. Rostris hispidulis 0.1–0.3 mm longis, minute bidentatis abrupte flexis. Achaeniis 2.0–2.4 mm longis (1.1–) 1.4–1.9 mm latis obovatis (vel ellipticis) trigonis per perigynium arcte involutis, cinnamomeis vel "Prout's brown," laevis vel papillosis in magnificatio alto; superficies duabus convexis et superficie una concava. Stylo marcescenti recti; stigmatibus tribus brunneis; antheris tribus 2.1–2.4 mm longis, luteolis.

Plants cespitose with stiff fibrous dark brown roots not felted with root hairs, and lacking inter-connecting rhizomes; fertile culms 4–12 cm tall, conspicuously trigonous with flared, antrorsely scaberulous margins. Leaves 3–5 per fertile culm, all basal, sheaths persistent and becoming fibrous with age, forming a brown fibrous base 3–5 cm tall; blades (5–) 9–31 cm long, (0.5–)1.2–2.0 mm wide, flat, striate; adaxial surface sparsely antrorsely scaberulous proximally becoming predominantly antrorsely scaberulous distally with midvein being impressed; abaxial surface glabrous with midvein raised proximally becoming strongly keeled distally, the margins minutely roughened to antrorsely scaberulous; leaf sheaths 1.5–5 cm long, more or less tightly enveloping culms and basal peduncles, basal leaf sheaths of previous years' leaves Mikado brown (Smithe 1975), leaf sheaths with blades (uppermost leaves) white to pale green, striate, membranous, minutely antrorsely scaberulous; apex of inner band of sheaths truncate, or minutely concave, not callosed or discolored; ligules absent or to 1 mm long, white-membranous, when elongated more or less linguliform. Vegetative shoots 3–5 cm tall; leaves 3–5, similar to those of fertile culm. Inflorescence of 4–6 spikes; lowest bract of fertile culm with a sheath 2.5–3.0 mm long; blade 1–18 mm long, ca. 0.5 mm wide, shorter than to slightly exceeding the inflorescence; fertile culm of 2–3 basal pistillate spikes and 3 terminal spikes. Basal 2–3 spikes pistillate, 3–4 cm long arising at base of fertile culm with obscurely trigonous peduncles with two edges antrorsely scaberulous, spike

FIG. 1. *Carex lativena*, from *S. & G. Jones 6523* (HOLOTYPE: MICH). A. Habit. B. Inflorescence. C. Sheath and Ligule. D. Pistillate scale. E. Perigynium, side view. F. Perigynium, front view. G. Perigynium, top view. H. Achene, front view. I. Achene, top view. J. Staminate scale. K. Anther. Bar equals 5 cm in A, 5 mm in B–C, and 1 mm in D–K.

arising from uppermost leaf sheath or beginning ca. 1 cm above; lowermost spikes with (4–) 6 perigynia. Lowermost and penultimate terminal spikes pistillate, 5–7 mm long, with 3–6 perigynia; uppermost terminal spike staminate,

gynaecandrous, or intermixed with both male and female flowers, 7–8 mm long; lowermost and penultimate spikes on a 2–3 mm long peduncle and the uppermost spike on a 3–4 mm long peduncle. Peduncle of lowermost and penultimate terminal pistillate spikes are plano-convex with antrorsely scaberulous edges; peduncle of uppermost terminal spike is sharply trigonous and antrorsely scaberulous. Pistillate scales glabrous 3.5–4.2 mm long, 1.3–2.0 mm wide, obovate, truncate basally, acuminate apically, midvein frequently excurrent to ca. 0.3 mm long; midvein occasionally scaberulous distally; pistillate scales with broad hyaline margins, light green in center with 3–5 conspicuous veins and occasionally with 3–5 smaller lateral veins. Staminate scales glabrous, 4–5 mm long, 1.5–2.1 mm wide, oblong to narrowly obovate, truncate basally, acuminate apically, midvein occasionally excurrent to 0.2 mm long; staminate scales mostly hyaline, with a light brown area around midvein ca. 0.2 mm wide, numerous faint lateral veins. Perigynia appressed, (3.0–) 3.5–3.8 (–4.0) mm long, (1.1–) 1.4–1.9 (–2.1) mm wide, obovate, tapering basally, trigonous with two apical sides convex and one side flat to slightly concave, mostly stramineous with some pale green color, mostly glabrous but sparsely hispidulous apically, faces of perigynia with 5–9 conspicuous veins, mostly 0.1 mm wide, veins on each adaxial corner even more conspicuous. Beaks hispidulous, 0.1–0.3 mm long, minutely bidentate, abruptly bent. Achenes 2.0–2.4 mm long, (1.1–) 1.4–1.9 mm wide, obovate (or elliptic), trigonous, tightly enveloped by the perigynium, cinnamon-brown or Prout's brown (Smithe 1975), smooth to minutely pappilose under high magnification, angles beige or cream colored; two of the faces usually convex and one face flat or concave. Style withering, straight. Achene epidermal cells (Fig. 5a) non-isodiametric, single central body in each cell (± conical), with a strongly concave silica platform of a bumpy texture and without satellites at the cell angles; anticlinal wall, appearing as a double weld, separates each cell. Stigmas 3, brown. Stamens 3, anthers 2.1–2.4 mm long, pale yellow.

TYPE: **U.S.A. TEXAS. Brewster Co.:** Big Bend National Park: 0.8 km southward on the Pinnacle's trail towards Boot Springs from the trail head near the Post Office, ca. 1735 m, 19 Apr 1991, *S. & G. Jones 6523* (HOLOTYPE: MICH; ISOTYPES: BRIT/SMU, TAES, TEX, US, VDB). The plants collected from Big Bend National Park (BIBE) have been assigned a National Park accession number 759 in addition to the collectors' accession number.

Additional specimens (PARATYPES): ARIZONA. **Cochise Co.:** Scheelite Canyon in the Huachuca Mountains, shaded slope in canyon bottom woodland, ca. 1770 m, 7 May 1991, *J. Bowers 3484 and S. McLaughlin* (ARIZ). TEXAS. **Brewster Co.:** steep limestone slopes, main canyon on west side of Santiago Mts., ca. 8 mi SE of Santiago Peak, 5 Apr 1948, *R. McVaugh 7849* (MICH); Big Bend National Park; Pine Canyon, ca. 1735 m, 21 Apr 1991, *S. & G. Jones 6547* (SRSC). **Runnels Co.:** 0.3 mi N on FR 382 from its jct. with county road 189, S of Lawn at Ranger Peak, ca. 704 m, calcareous loamy clay soil, 28 Mar 1992, *S. & G. Jones 8194* (ASTC, BRIT/SMU, ctb = Charles T. Bryson's pers. herb., MICH, mjo = Michael J. Oldham's pers. herb., SAT, sdj = Stanley D. Jones' pers. herb., SWT, vem = Vern E. McNeilus' pers. herb., VSC, UTEP). **Taylor Co.:** on N slope of Edwards Escarpment at Camp Barkeley, rocky soil, dominated by juniper, 28 Mar 1943, *W. Tolstead 6915* (BRIT/SMU, MICH, TAES).

Carex lativena was found growing under and near junipers and piñyon pines in an open, semi-dry mixed hardwood conifer forest on a north-facing slope at an elevation of ca. 1735 m. The soils are of the Mainstay-Liv-Brewster association, noncalcareous, gravelly silt loam, grayish brown, neutral with igneous rock outcrops. Associated species include *Astragalus mollissimus* Torr., *Castilleja nervata* Eastw., *Poa fendleriana* (Steud.) Vasey, *P. bigelovii* Vasey & Scribner, *Carpochaete bigelovii* Gray, *Stipa tenuissima* Trin., *Carex geophila* Mackenzie, *Conopholis alpina* Liebm., *Elymus elymoides* (Rafin.) Swezey, *Ceanothus greggii* Gray, *Garrya ovata* Benth., *Galium pilosum* Ait., *Fraxinus cuspidata* Torr., *Pinus cembroides* Zucc., *Acer grandidentatum* Nutt., *Juniperus flaccida* Schlecht., *J. ashei* Buchloz, *Cheilanthes tomentosa* Link, *C. eatonii* Baker in Hook. & Baker, *Pellaea atropurpurea* (L.) Link, *P. intermedia* Mett. *ex* Kuhn, *Notholaena sinuata* (Lag. *ex* Swartz) Kaulf., *Arbutus xalapensis* Kunth in H.B.K., and *Quercus* spp. The following key is for species of section *Triquetrae*.

KEY TO SECTION *TRIQUETRAE*

1. Perigynia abruptly contracted into a beak 1.0–1.3 mm long (Fig. 2b); culms trigonous, angles flattened into wings, sparsely pilose; leaves pilose throughout ..... *C. hirtifolia*
1. Perigynia tapering to the beak, or if abruptly contracted, the beaks less than 0.6 mm long (Figs. 2a, c–f); culms trigonous, rounded or sharp, but not flattened into wings, glabrous to antrorsely scaberulous; leaves glabrous to scaberulous or pilose basally in *C. dasycarpa*.
   2. Faces of perigynia with 4- many conspicuous veins; plants of central-eastern U.S., Guatemala, Mexico, or eastern Canada, but not California nor Baja California.
      3. Culms with basal spikes
         4. Achenes brown, apices retuse, 2 of the 3 faces usually convex; basal spikes 2–3 per culm; faces of perigynia with 5–9 conspicuous veins of about the same width (0.1 mm) with 1–2 thinner (Fig. 2c) ..... *C. lativena*
         4. Achenes light green to golden yellow (rarely light brown), apices obtuse, not retuse, 2 of the 3 faces usually concave; basal spikes 0–1 (–2) per culm; faces of the perigynia with (4–) 6 (–8) conspicuous veins less than 0.1 mm wide accept for the two veins on the adaxial corners which are ca. 0.1 mm wide (Fig. 2d) ..... *C. planostachys*
      3. Culms without basal spikes.
         5. Perigynia densely white-villous except at base (Fig. 2a); achene body 2.0–2.7 mm long, long-stipitate (Fig. 3a) ..... *C. dasycarpa*
         5. Perigynia puberulent (Fig. 2e); achene body 3.0–3.3 mm long, sessile (Fig. 3b) ..... *C. tenax*
   2. Faces of perigynia with (0–) 1 (–3) conspicuous veins (Fig. 2f); plants of California south into northern Baja California ..... *C. triquetra*

In addition to key characters separating *C. lativena* (Fig. 1) from its closest putative relative *C. planostachys* (Fig. 4), it differs in not having inter-connecting rhizomes. Both are cespitose in habit, but the cespitose clumps of *C. lativena* are

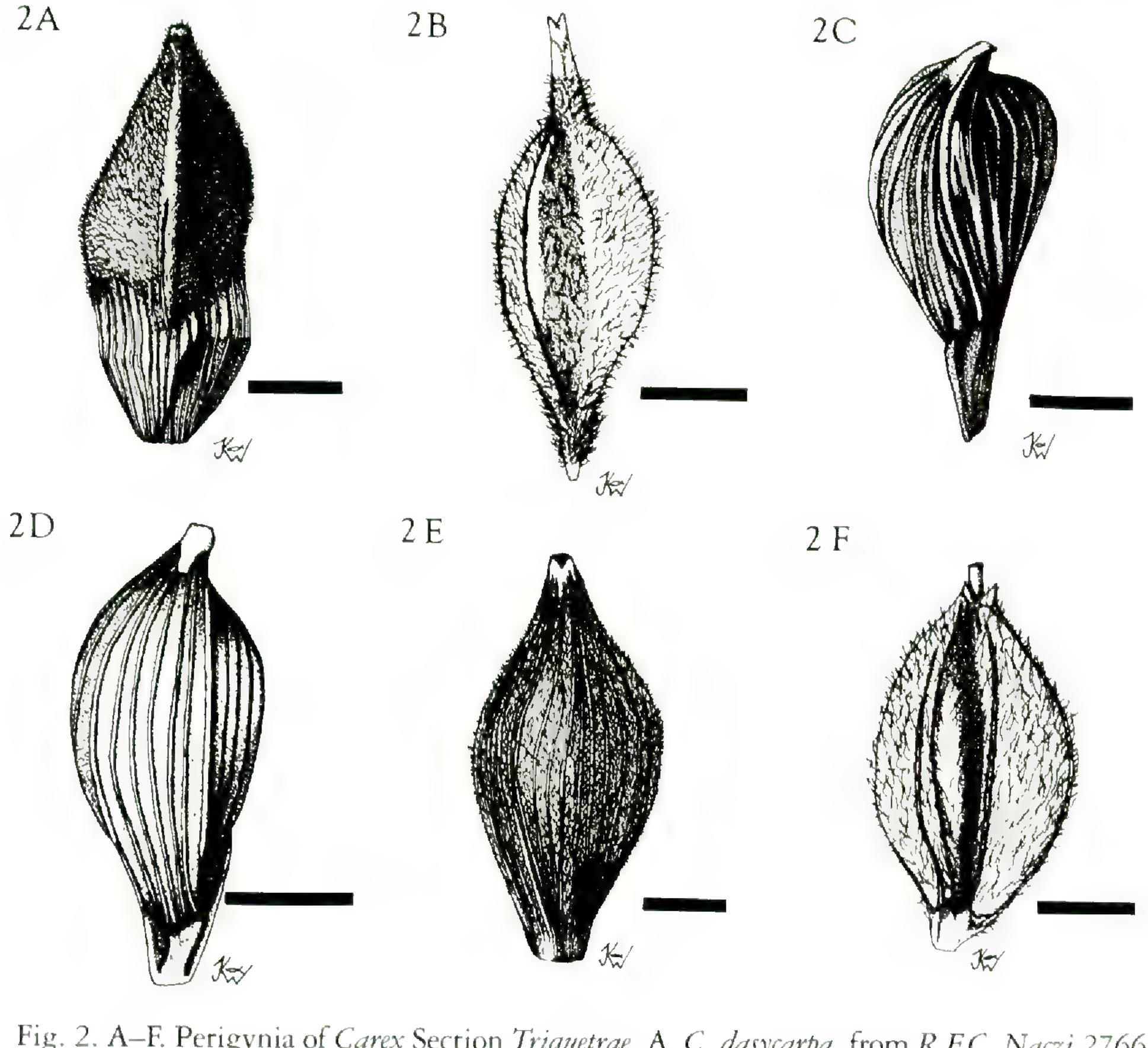

Fig. 2. A–F. Perigynia of *Carex* Section *Triquetrae*. A. *C. dasycarpa*, from *R.F.C. Naczi 2766* (sdj - pers. herb. of Stanley D. Jones). B. *C. hirtifolia*, from *H.E. Ables 87908* (TAES). C. *C. lativena*, from *S. & G. Jones 6523* (isotype: TAES). D. *C. planostachys*, from *S. & G. Jones 1269* (TAES). E. *C. tenax*, from *S. & G. Jones 2600* and *T. Powell* (TAES). F. *C. triquetra*, from *F.R. Fosberg 54645* (TAES). Bar equals 1 mm in A–F.

composed of individual plants that can be pulled apart from each other. Whereas, with *C. planostachys*, most of the plants of a cespitose clump are inter-connected by rhizomes. *Carex lativena* also differs in having more numerous and shorter basal peduncled pistillate spikes; shorter culms; perigynia that are conspicuously obovate, less pubescent and with shorter, abruptly bent beaks. *Carex planostachys* has more or less fusiform perigynia that are uniformly pubescent, and longer beaks, that are only slightly curving. The achenes also differ micromorphologically. The achenes of *C. lativena* (Fig. 5a) and *C. planostachys* (Fig. 5b) have a central silica body with no satellites, and a conspicuously concave silica platform. However, *C. lativena* has a conspicuous anticlinal wall appearing as a double weld, and a bumpy textured silica platform (Fig. 5a), while *C. planostachys* has an inconspicuous anticlinal wall, and a smooth textured silica platform (Fig. 5b).

The conspicuous broad veins on the faces of the perigynia of *C. lativena* are the

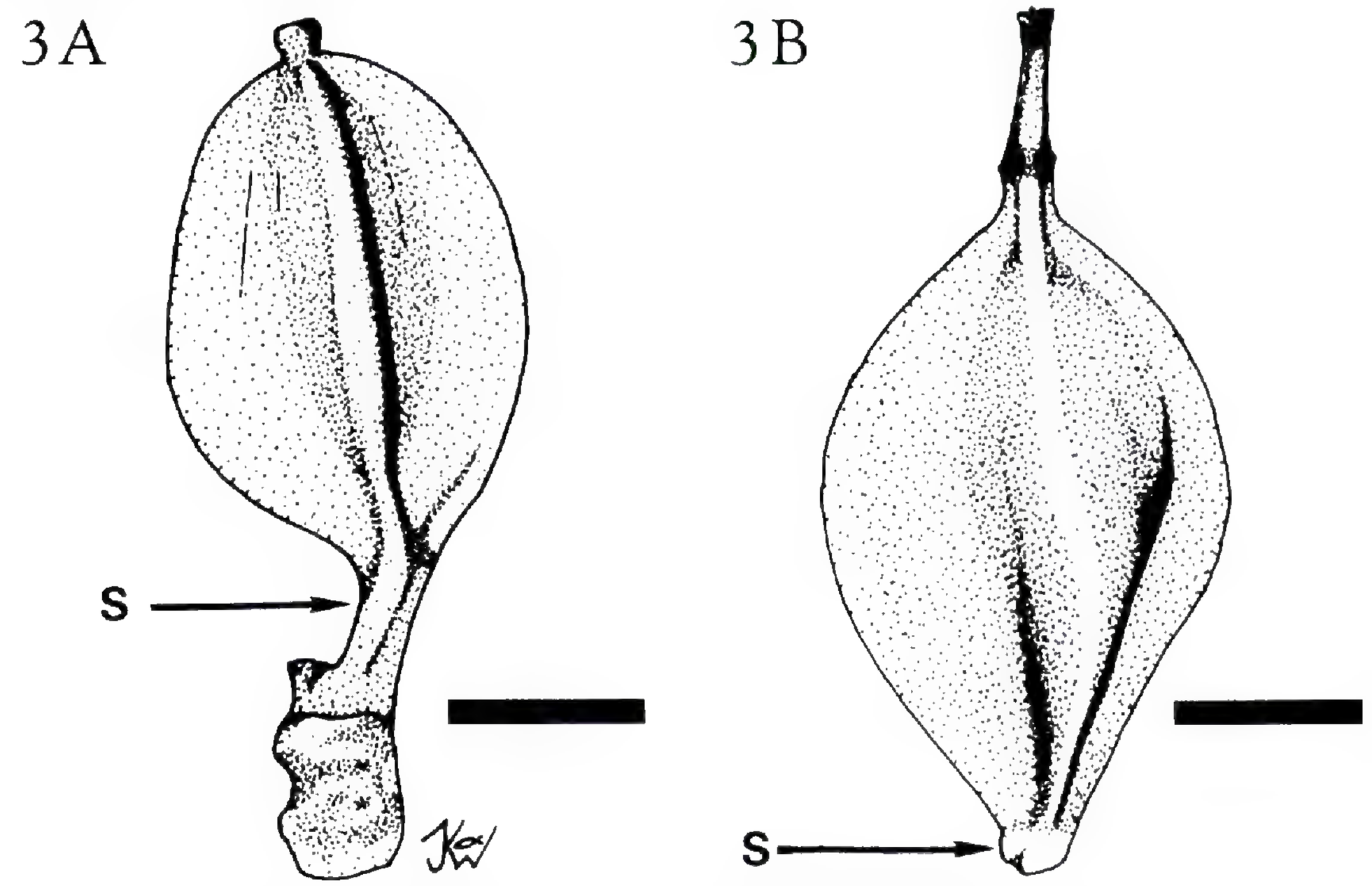

Fig. 3. A, B. Achenes. A. *Carex dasycarpa*, from *R.F.C. Naczi 2766* (sdj = pers. herb. of Stanley D. Jones). B. *C. tenax*, from *S. & G. Jones 2600* and *T. Powell* (TAES). S. stipe. Bar equals 1 mm in A, B.

derivation of both its scientific and common name. It has been collected in Brewster, Runnells, and Taylor counties, Texas, representing three vegetational regions in the state based on Hatch et al. (1990): region 7 (Edwards Plateau), region 8 (Rolling Plains), and region 10 (Trans-Pecos) from where it is described. In addition to being found in three counties in Texas, it has been collected in Cochise County, Arizona, where it was reported new to Arizona as *C. planostachys* by Bowers and McLaughlin (1993). *Carex lativena* was growing in association with *Pinus cembroides* (piñon pine) at the type locality. We suspect that *C. lativena* may have an association with them. However, piñon pine was not present at the Taylor nor Runnels County sites, which are part of the Callahan Divide. Whether, historically piñon pine existed at these sites or not is unclear. Further field studies in piñon pine belts in Texas, adjacent Mexico, and the southwest US are suggested.

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The discovery of this new species is the result of research conducted under a BIBE permit. We appreciate Mike Fleming, Resource Management Specialist (BIBE) for providing permits and cooperation throughout this research. We thank Charles T. Bryson (SWSL), Paul A. Fryxell (USDA), A.A. Reznicek (MICH), and J.K. Wipff (TAES) for their manuscript review. We are also grateful

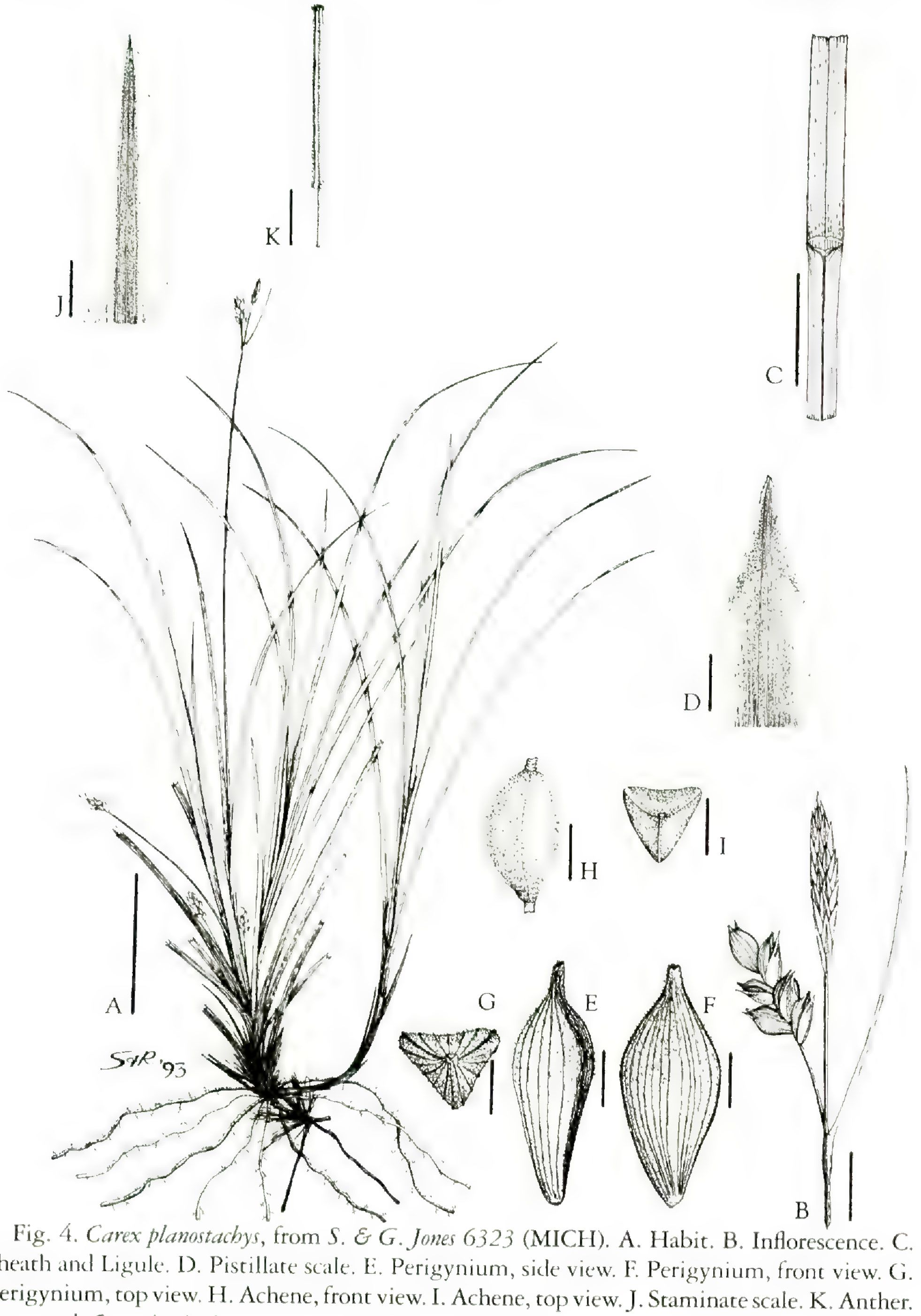

Fig. 4. *Carex planostachys*, from *S. & G. Jones 6323* (MICH). A. Habit. B. Inflorescence. C. Sheath and Ligule. D. Pistillate scale. E. Perigynium, side view. F. Perigynium, front view. G. Perigynium, top view. H. Achene, front view. I. Achene, top view. J. Staminate scale. K. Anther. Bar equals 5 cm in A, 5 mm in B, C, and 1 mm in D–K.

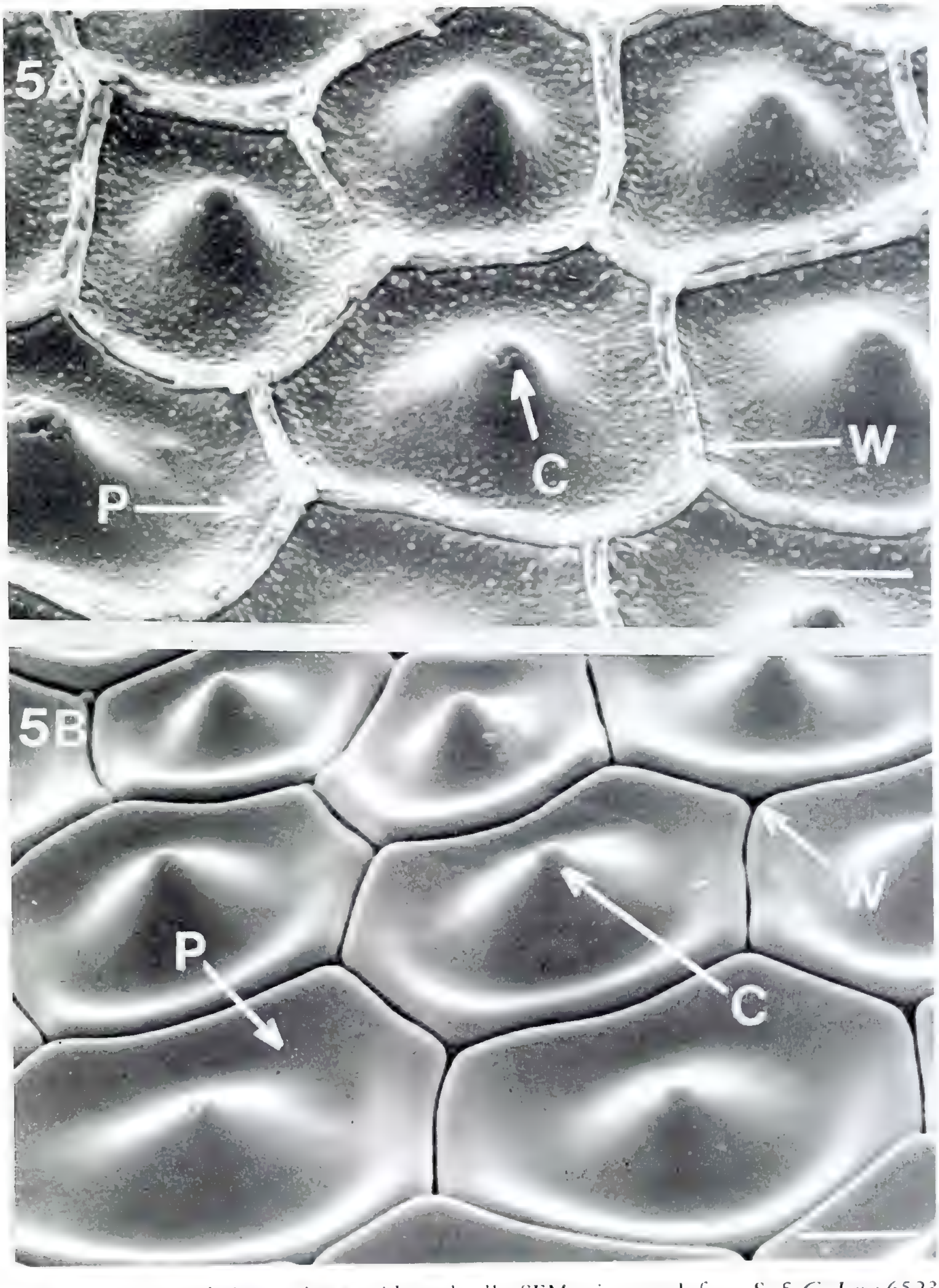

Fig. 5. A. *Carex latirena* achene epidermal cells, SEM micrograph from *S. & G. Jones* 6523 (isotype: TAES). C. Central body. P. Silica platform. W. Anticlinal wall. Bar equals 10μm. B. *C. planostachys* achene epidermal cells, SEM micrograph from *S. & G. Jones* 6323 (TAES). C. Central body. P. Silica platform. W. Anticlinal wall. Bar equals 10μm.

to Paul A. Fryxell for correcting our Latin description, Susan A. Reznicek for the illustration of *C. lativena* and *C. planostachys* (Figs. 1, 4), and to J.K. Wipff for the illustration of Figs. 2 and 3.

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THE FLORA OF CHICKEN KEY, DADE COUNTY, FLORIDA: BEFORE AND AFTER HURRICANE ANDREW

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ABSTRACT

Complete lists of the species of vascular plants in the flora of Chicken Key in Dade County Florida were generated during surveys of the key on five occasions over a period of five years, including surveys conducted just before and just after Hurricane Andrew (which impacted the key on 24 Aug 1992). Although the short term effect on the species richness of the key was dramatic (a drop from 72 to 63 species), the post hurricane species richness is still well within the known range for the island, indicating that the long term effects on the species composition may not be significant.

RESUMEN

Se realizo la lista completa de plantas vasculares del "Chicken Key" (Cayo Pollo) en el condado de Dade de Florida. Fue elaborada en cinco visitas, durante un período de cinco años, e incluyen reconocimientos ilevados a cabo inmediatamente antes e inmediatamente depué del huracán Andrew (que afectó el cayo el 24 de agosto de 1992). A pesar de que el impacto inmediato en el número de especies fue dramático (una reducción de 72 a 63 especies), la diversidad después del huracán está aun dentro del rango normal para la isla, indicando que los efectos a largo plazo sobre la composición de la flora, probablemente no sea significativo.

INTRODUCTION

Chicken key is a natural sand island located at 25°37'15 "N. lat. and 80°17'9 W. long. in Biscayne Bay approximately 3/4 km south of Paradise Point, just south of Miami, Florida. Although only 2.8 ha in size, the island has more relief than a typical sand key due to a large oölite mound on its northern half made by the deposition of spoil from the dredging of a nearby canal in the 1940s. This operation changed the substrate from sand to bare oölite and the relief from one meter to just over two meters above sea level (Babb et al. 1991), thereby allowing colonization by a number of non-native and native plant species found more often in nearby pine rocklands.

The key is part of the Charles Deering Estate, a state-owned property administered by the Metro-Dade County Park and Recreation Department. There are no permanent structures on the island and although it has been popular as a campsite since settlement of the area, it has never sustained a permanent

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domicile. The Deering Estate has no plans to develop the island beyond the possible construction of a small docking facility and has posted it as a no trespassing area since 1987 (Babb et al. 1991).

The mangroves on the west side of the island are a major roosting area and rookery for several species of birds. Those observed roosting there included several herons (*Ardea herodias, Florida caerulea, Hydranassa tricolor* and *Butorides striatus*), egrets (*Casmerodius albus Egretta thula*), pelicans (*Pelecanus occidentalis*), and cormorants (*Phalacrocorax auritus*). The key is bordered on the east by a submerged sand bar and on the west by soft bottom shallows. *Thalassia testudinum* Koenig., *Halodule wrightii* Aschers and *Cymodocea filiformis* (Kuetz.) Correll are the common marine angiosperms found in the shallows.

This project began as a simple floristic treatment in 1987. From this treatment a preliminary manual was produced (Guala 1991). However, it is clear from the data presented here that the composition of flora of Chicken Key is dynamic and only long term studies such as the one presented here can truly describe the nature of the flora.

METHODS

In 1987 several trips were made to the key during the last week of July and a complete plant species list was generated. The key was then revisited on 26 Apr 1988, 24 Mar 1989 and 22 Jul 1992 and resurveyed, first for all species previously found in the flora, and then for additions. On 14 Sep 1992, two weeks after Hurricane Andrew, a preliminary post-hurricane trip was made to the key and on 24 Oct 1992 a complete resurvey was done.

All of the species found in 1987 and all subsequent additions to the flora are vouchered at the herbarium of the Fairchild Tropical Garden (FTG) and a duplicate set of the 1987 collections is deposited at Michigan State University (MSC).

Species nomenclature follows Wunderlin (1982) and updates (Wunderlin et al. 1985, 1988) except where noted (see footnotes 1-10). Family circumscriptions and nomenclature used here are primarily those of Lellinger (1985) for the ferns and Thorne (1992) for the flowering plants. However, recent work by Judd et al. (submitted) has shown that some modifications are necessary in order to achieve strictly monophyletic family circumscriptions. They have shown that Moraceae are paraphyletic without the inclusion of Urticaceae s.s. and, therefore, the two must be combined (as in Thorne 1983). The same holds true for the Apiaceae/Araliaceae pair, the Araliaceae s.s. being paraphyletic and Umbelliferae (Apiaceae) polyphyletic. Celtidaceae are recognized here because it is now clear, through the work of Grudzinskaia (1967) that this group shares no synapomorphies with the Ulmaceae s.s., although both are individually monophyletic. The Celtidaceae, according to Judd et al. (submitted) may be more closely related to Urticacreae s.l. than to the Ulmaceae s.s.

RESULTS

The actual numbers of species encountered on the 87, 88, 89, Jul 92 (hereafter designated 92I) and Oct 1992 (hereafter designated 92II) surveys were 60, 62, 65, 73, and 62 respectively. One species, *Sapindus saponaria*, was lost and three; *Melothria pendula, Phytolacca rigida,* and *Stenotapharum secundatum* were gained between the 1987 and 1988 surveys. Between the 1988 and 1989 surveys, four species, *Ficus altissima, Lysiloma latisiliqua, Spermacoce verticillata,* and *Trema micrantha*, were gained and only *Spartina spartinae* was lost. During the three years preceding the first 1992 survey only three species, *Blechum brownei, Catharanthus roseus,* and *Phytolacca rigida*, were lost but 12, *Baccharis halimifolia, Boerhavia diffusa, Dalbergia ecastophyllum, Desmodium incanum, Ficus microcarpa, Ipomoea pes-caprae, Passiflora suberosa, Phyllanthus tenellus, Psilotum nudum, Setaria geniculata, Sida acuta*, and *Vitis rotundifolia* were gained. Eleven species, *Baccharis halimifolia, Borrichia fructescens, Canavalia rosea, Chamaesyce buxifolia, Dalbergia ecastophyllum, Ficus microcarpa, Ipomoea pes-caprae, Pteris bahamense, Stenotapharum secundatum, Suriana maritima,* and *Urechites lutea* were found in the pre-hurricane (92I) survey but not the post-hurricane (92II) survey. The percentage of non-native species in both of the 1992 surveys is about 23%.

Appendix I contains a list of all species encountered over the course of the study. Each species is followed by the collection number of the author in brackets and the years in which it was encountered. The two trips in 1992, 92I and 92II, are the two full surveys completed before and after the hurricane. Also included at the end is a designation of native or non-native. Native is defined as putatively occurring in South Florida before European colonization.

DISCUSSION

The flora of Chicken Key, like that of most islands, is dynamic (MacArthur & Wilson 1967). The flora has been subjected to numerous catastrophes, both human induced and natural, which must have significantly altered the floristic composition over the years. In 1987 (before the first survey) a fire burned for three days on the island and destroyed much of the vegetation on the oölite mound which is itself the product of major disturbance. Although it is impossible to know the entire effect of previous disturbances, Hurricane Andrew, which directly passed over the key on August 24, 1992 (4 weeks after the first 1992 survey) provided a rare opportunity to observe the impact of a catastrophic natural disturbance on the floristic composition of the key.

During the hurricane the key experienced the harshest part of the storm extrapolating from the maps in Rapaport (1992). It was on the subjected to sustained winds of nearly 250 kph with gusts of 280 kph and a storm tide of over 5 m (estimated from Rapaport 1992). Every tree on the key was defoliated and showed at least some structural damage. More than 60% of the larger trees, including mangroves, were at least partially uprooted or snapped below the crown.

It is surprising that only 11 of the species recorded in July were not found again after the storm. All of the species that survived the storm, except *Cordia sebestena* with a single remaining individual, were represented by at least three apparently healthy individuals. Many of the species, including *C. sebestena* were in mass flower on October 24th.

Although exact numbers of individuals of each species were not recorded in any of the surveys, notes on the approximate number of individuals were kept for most of the less common native species and newly introduced non-natives. As one might expect, most of the species putatively extirpated by the storm were only represented on the key by a few individuals before the storm.

Furthermore, it would not be surprising if several of the putatively extirpated species returned from the seed bank, dormant subterranean organs or redispersal to the island. There was an influx of organic matter and devegetation of several areas which would probably aid the majority of lost species in their re-establishment.

Before the hurricane the island gained an average of about four species and lost one every year. This net gain may show that the species richness of the island was still recovering from some past degradation (most likely the fire) and that three species per year is a reasonable recovery rate to use for extrapolation. We can then propose that the island should regain its maximum known diversity in about four years. The unique substrate changes made by the creation of the oölite mound, the island's small and everchanging size, and the unknown difference between actual and effective distance from land make it nearly impossible to accurately calculate what the maximum possible diversity would be.

In conclusion, the massive destruction and reduction in standing biomass imposed by Hurricane Andrew was certainly significant. However, because the species richness of the island is still within the known long term range with virtually no change in the percentage of exotics it appears that the long term effects on the composition of the flora will be minimal.

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APPENDIX I. List of the vascular plant species on Chicken Key.

Name	Voucher No.	87	88	89	92I	92II	Native
ACANTHACEAE							
Blechum brownei Juss.	733	+	+	+		+	
AIZOACEAE							
Sesuvium portulacastrum L.	710	+	+	+	+	+	+
AMARANTHACEAE							
Blutaparon vermiculare (L.) Mears	709	+	+	+	+	+	+
AMARYLLIDACEAE							
Hymenocallis latifolia (Mill.) Roem.	678	+	+	+	+	+	+
ANACARDIACEAE							
Metopium toxiferum (L.) Krug & Urban	719	+	+	+	+	+	+
Schinus terebinthifolius Raddi	720	+	+	+	+	+	
APIACEAE							
Schefflera actinophylla (Endl.) Harms	679	+	+	+	+	+	
APOCYNACEAE							
Catharanthus roseus (L.) G. Don	713	+	+	+			
Echites umbellata Jacq.	687	+	+	+	+	+	+
Urechites lutea (L.) Britt.	724	+	+	+	+		+
ASTERACEAE							
Baccharis halimifolia L.	1487			+		+	
Bidens alba (L.) DC var. *radiata* (Sch.-Bip.) Ball. ex Melch.	691	+	+	+	+	+	+
Borrichia arborescens (L.) DC[1]	702	+	+	+	+	+	+
Borrichia fructescens (L.) DC	705	+	+	+	+		+
Conyza canadensis (L.) Cronquist var. *pusilla* (Nutt.) Cronquist	706, 711	+	+	+	+	+	+
Eupatorium serotinum Michx.	707	+	+	+	+	+	+
Pluchea carolinensis (Jacq.) G. Don[2]	728	+	+	+	+	+	+
AVICENNIACEAE							
Avicennia germinans (L.) L.	676	+	+	+	+	+	+
BORAGINACEAE							
Cordia sebestena L.[3]	722	+	+	+	+	+	+
Heliotropium angiospermum Murray	690	+	+	+	+	+	+
Heliotropium curassavicum L.	712	+	+	+	+	+	+
BURSERACEAE							
Bursera simaruba (L.) Sarg.	737	+	+	+	+	+	+
CASUARINACEAE							
Casuarina equisetifolia L.	681	+	+	+	+	+	
CELTIDACEAE							
Trema micrantha (L.) Blume	1156, 1478			+	+	+	+
COMBRETACEAE							
Conocarpus erectus L. var. *erectus*	1480	+	+	+	+	+	+
Laguncularia racemosa Gaertn.	685	+	+	+	+	+	+

[1]This species not included in Wunderlin (1982, 1985, 1988). See Long & Lakela (1971) for reference.
[2]*Pluchea symphytifolia* (P. Mill.) Gillis is not valid, see Howard (1988) for a discussion.
[3]D.B. Ward (pers. comm.) has expressed doubt about the native status of this species and is currently studying the question.

APPENDIX I. List of the vascular plant species on Chicken Key (continued).

Name	Voucher No.	87	88	89	92I	92II	Native
CONVOLVULACEAE							
Ipomoea indica (Burm. f.) Merr.	699, 700	+	+	+	+	+	+
Ipomoea violacea L.	735, 738	+	+	+	+	+	+
Ipomoea pes-caprae (L.) R.Br. subsp. *brasilensis* (L.) Van Oöstr.	1488			+		+	
CUCURBITACEAE							
Melothria pendula L.	745		+	+	+	+	+
DENNSTAEDTIACEAE							
Pteridium caudatum (L.) Maxon	715	+	+	+	+	+	+
EUPHORBIACEAE							
Chamaesyce blodgettii (Engelm. ex Hitchc.) Small	726	+	+	+	+	+	+
Chamaesyce buxifolia (Lam.) Small[4]	725	+	+	+		+	+
Chamaesyce hypericifolia (L.) Millsp.	697	+	+	+	+	+	+
Phyllanthus tenellus Roxb.	1485		+	+			
Poinsettia cyathophora (Murray) Kl. & Gke	736	+	+	+	+	+	+
FABACEAE							
Acacia auriculiformis A. Cunn. & Benth.[5]	708	+	+	+	+	+	
Caesalpinia bonduc (L.) Roxb.	732	+	+	+	+	+	+
Canavalia rosea (Sw.) DC	727	+	+	+	+	+	
Dalbergia ecastophyllum (L.) Taub.	1476				+		+
Desmodium incanum DC	1490				+	+	
Lysiloma latisiliqua (L.) Benth.[6]	1477			+	+	+	
LAMIACEAE							
Callicarpa americana L.	739	+	+	+	+	+	+
MALVACEAE							
Hibiscus tiliaceus L.	680	+	+	+	+	+	
Sida acuta Burm. f.	1486				+	+	+
Thespesia populnea (L.) Solander ex Correa	683	+	+	+	+	+	
NYCTAGINACEAE							
Boerhavia diffusa L.	1484				+	+	+
PASSIFLORACEAE							
Passiflora suberosa L.	1475				+	+	+
PHYTOLACCACEAE							
Phytolacca rigida Small	743		+	+			+
POACEAE							
Andropogon glomeratus (Walt.) BSP	723	+	+	+	+	+	+
Cenchrus echinatus L.	692	+	+	+	+	+	+
Chloris petrea Swartz[7]	717	+	+	+	+	+	+

[4]I accept the more conservative argument of Webster & Burch (1967) rather than recognizing the later combination *Chamaesyce mesembrianthemifolia* (Jacq.) Dugand.
[5]This species is not included in Wunderlin (1982, 1985, 1988). See Correll & Correll (1982) for reference.
[6]Ibid.
[7]I find no synapomorphy for *Chloris* if sect. *Eustachys* is removed from it.

APPENDIX I. List of the vascular plant species on Chicken Key (continued).

Name	Voucher No.	87	88	89	92I	92II	Native
Dactyloctenium aegyptium (L.) Beauv.	684	+	+	+	+	+	
Neyraudia reynaudiana (Kunth) Keng ex Hitchc.[8]	677, 1158, 1159	+	+	+	+	+	
Paspalum setaceum Michx.	96	+	+	+	+	+	
Schizachyrium sanguineum (Retz.) Alston	694	+	+	+	+	+	+
Setaria geniculata (Lam.) Beauv.	1479				+	+	+
Spartina spartinae (Trin.) Merr. ex Hitchc.	729	+	+				+
Sporobolus indicus (L.) R. Br.	693	+	+	+	+	+	+
Stenotapharum secundatum (Walt.) Kuntze	744		+	+	+		
POLYGONACEAE							
Coccoloba uvifera (L.) L.	682	+	+	+	+	+	+
PSILOTACEAE							
Psilotum nudum (L.) Sw.	489				+	+	+
PTERIDACEAE							
Pteris bahamense (Agar.) Fée	714	+	+	+	+		+
RHAMNACEAE							
Colubrina asiatica (L.) Brongn.	716	+	+	+	+	+	
RHIZOPHORACEAE							
Rhizophora mangle L.	730	+	+	+	+	+	+
RUBIACEAE							
Morinda royoc L.	688	+	+	+	+	+	+
Spermacoce verticillata L.	1157			+	+	+	
SAPINDACEAE							
Dodonaea viscosa (L.) Jacq.	698	+	+	+	+	+	+
Sapindus saponaria L.	734	+					+
SURIANACEAE							
Suriana maritima L.	721	+	+	+	+		+
URTICACEAE							
Ficus altissima Blume[9]	1160, 1482			+	+	+	
Ficus aurea Nutt.	686	+	+	+	+	+	+
Ficus microcarpa L.f.[10]	1481				+		
VERBENACEAE							
Lantana camara L.	704	+	+	+	+	+	
Phyla nodiflora (L.) Greene	731	+	+	+	+	+	+
Stachytarpheta jamaicensis (L.) Vahl	689	+	+	+	+	+	+
VITACEAE							
Parthenocissus quinquefolia (L.) Planchon	695	+	+	+	+	+	+
Vitis rotundifolia Michx.	1483	+	+	+	+	+	+

[8]This species is not included in Wunderlin (1982, 1985, 1988). See Guala (in review) for reference.
[9]This species is not included in Wunderlin (1982, 1985, 1988). See Howard (1988) for reference.
[10]Ibid.

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FIRST RECORD OF *ECHINOCHLOA STAGNINA* (POACEAE) FOR PUERTO RICO AND KEY TO THE *ECHINOCHLOA* IN THE WEST INDIES

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Echinochloa stagnina (Retz.) Beauv. (Fig. 1), commonly called "hippo grass," "Burgu grass," or "long-awned water grass" (Wells et al. 1986) is native to tropical and subtropical Africa, including Madagascar. It has become naturalized in India, Vietnam, Thailand, the Philippines, and Indonesia (Michael 1983). It is a robust,

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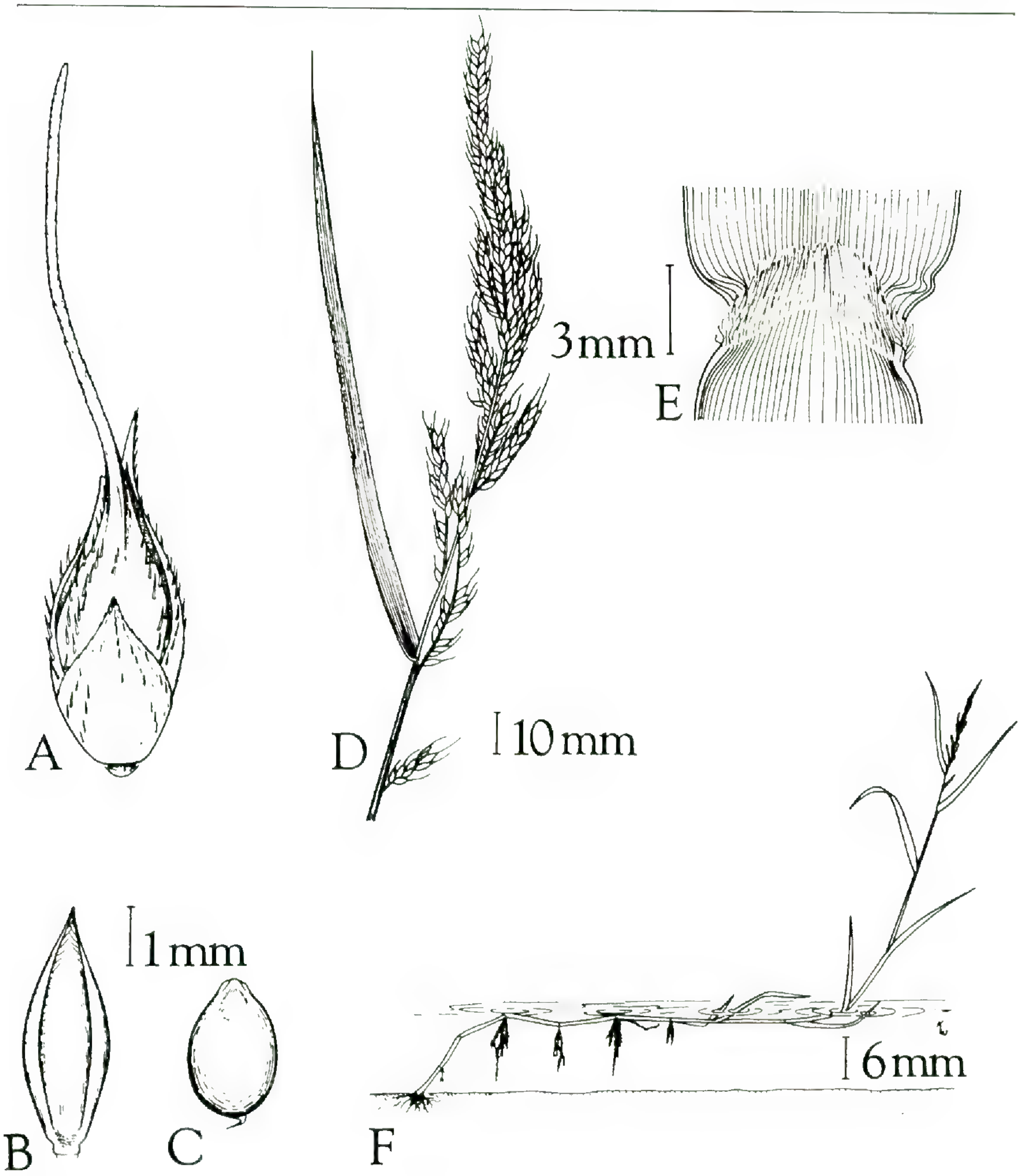

FIG. 1. *Echinochloa stagnina* (Retz.) Beauv.: A. Spikelet; B. Fertile floret; C. Caryopsis; D. Inflorescence; E. Ligule; F. Habit. Drawn from *Proctor 46386*.

usually perennial grass that reaches 1–2 meters in height and typically grows in the "mud of swamps, lakes, and rivers" (Stapf 1934). *Echinochloa stagnina* commonly floats on the water's surface and along with *E. pyramidalis* Hitchc. & Chase, is a major constituent of the large water meadows and floating islands on the Niger and Nile Rivers and Lake Chad in Africa (Chevalier 1901, Stapf 1934, Lazarides 1980). Because of its high sugar content, it is regarded as an excellent

forage grass in tropical Africa (Stapf 1934, Bor 1960, Degener and Degener 1960).

Echinochloa stagnina has been illustrated in Chevalier (1901) under the name, *Panicum burgu* A. Chev. and in Harker and Napper (1960: pl. 37) and Soerjani et al. (1987). It is an important weed of floating (deep-water) rice in tropical Africa, the Indian sub-continent and in Thailand (Yabuno 1966, Michael 1983). Due to its aggressive nature, it is considered as a problematic weed in several countries in southern Africa (Wells et al. 1986).

On 5 May 1987, the senior author collected this plant along an irrigation canal in southwestern Puerto Rico [Municipio: de Lajas, Barrio: Sabana Yeguas; ca. 0.4 km E of Rt. 116, and ca. 1.2 km due NE of Finca Juanita, elevation ca. 8–9 m, *McKenzie 704* (LSU, SJ, NSW)]. As in other localities where the species is native, many of the culms of *E. stagnina* at the Puerto Rican discovery site are submerged-aquatic, or floating on the water's surface (Fig. 1). Because inflorescences collected 5 May were immature, Proctor returned to the site on 18 May 1990, and collected specimens with mature spikelets [*Proctor 46386* (LSU, SJ, NSW)].

The population of *E. stagnina* in Puerto Rico consists of several hundreds of plants and observations of 5 May 1987 and 18 May 1990 suggest that the species is spreading. The introduction of hippo grass into Puerto Rico appears to be unintentional. It may have been accidentally introduced via rice seed or the seeds of forage grasses introduced to the island fromtropical Asia or tropical Africa.

This record constitutes the first record for Puerto Rico and possibly the West Indies. Michael examined a specimen (*Duss 3920*, F) from Guadeloupe, a duplicate of which Wiegand (1921) had named *E. guadeloupensis* (Hackel) Wieg., and concluded that it was referable to either *E. stagnina* or to the Asian species *E. picta* (Koen.) Michael, with which *E. stagnina* has often been confused (Matthew 1982, 1983). Because the spikelets of Duss's specimen are too immature for positive identification, we consider our record of *E. stagnina* as the first documented occurrence of this grass in the Caribbean.

Another specimen, *Duss 3176*, also from Guadeloupe, on which Hackel's name *Panicum spectabile* Nees var. *guadeloupense* was based is, however, as Hitchcock (1936:325–326) recognized, *E. pyramidalis*. Michael (1978) presented distinguishing criteria for *E. stagnina* and *E. picta* which Lazarides (1980) accepted in his treatment of the grasses of tropical Southeast Asia. *Echinochloa picta* has been illustrated under the name *E. stagnina* in both Degener and Degener (1960) and Reed (1977). *Echinochloa picta* has not been positively recorded for the Caribbean. It is however, likely to occur, as it has been collected in rice fields in Guyana (British Guiana).

Echinochloa stagnina resembles *E. polystachya* (H.B.K.) Hitchc. and *E. pyramidalis* of the West Indies in its robust, perennial habit, in the nature of its long trailing culms that often float on the water's surface, and in its ciliate ligules on

the lower leaf blades. *Echinochloa stagnina* can be distinguished from *E. polystachya* and *E. picta*, which also have ciliate ligules, by its more elliptical or lanceolate spikelets, and from *E. pyramidalis* by its long awned spikelets.

The accompanying key is comprised of the following species of *Echinochloa* known from or expected to occur in the West Indies: *E. colona* (L.) Link of tropical origin; *E. crus-galli* (L.) Beauv. of Eurasia; *E. glabrescens* Munro ex Hook. f., *E. oryzoides* (Ard.) Fritsch, and *E. picta* from Asia; *E. haploclada* (Stapf) Stapf, *E. pyramidalis*, and *E. stagnina* from Africa; *E. microstachya* (Wieg.) Rydb. (syn. *E. muricata* (Beauv.) Fern. var. *microstachya* Wieg.), *E. paludigena* Wieg., and *E. walteri* (Pursh) Heller from North America; *E. crus-pavonis* (H.B.K.) Schult. and *E. polystachya* from South America.

KEY TO THE SPECIES OF *ECHINOCHLOA* IN THE WEST INDIES

1a. Plants perennial
- 2a. Spikelets 2.0–3.0 mm long, with short awns; ligular cilia absent; plants close-tufted to 2.5 m tall ..... *E. haploclada*
- 2b. Spikelets longer than 3.0 mm; ligular cilia present, especially on lower leaves; plants with long creeping rhizomes or stolons.
  - 3a. Spikelets awnless or with short awns or long cusps up to 2.0 mm long, finely pubescent, or nearly glabrous; plants to 4.0 m tall with stout culms ..... *E. pyramidalis*
  - 3b. Spikelets with conspicuous bristles and awned, awns to 30.0 mm long.
    - 4a. Spikelets elliptical or lanceolate, up to 5.0 mm long, with awns to 18.0 mm long; plants floating in water with long trailing culms but rooted at bottom ..... *E. stagnina*
    - 4b. Spikelets obovate, broadly ovate, or ovate, with awns to 30.0 mm long.
      - 5a. Spikelets obovate, usually more than 5.0 mm long, awns 3.0–30.0 mm long; culms to 3.0 m tall; grass commonly found in flooded areas, swamps and ditches ..... *E. polystachya*
      - 5b. Spikelets broad-ovate or ovate, 3.0–4.0 mm long, with awns to 8.0 mm long; culms generally less than 1.0 m tall; grass commonly found in rice fields ..... *E. picta*

1b. Plants annual
- 6a. Lemma of fertile floret acute or acuminate with a stiff tip; inflorescence erect ..... *E. microstachya*
- 6b. Lemma of fertile floret with withering tip sharply differentiated from the body of the lemma; inflorescence erect or nodding.
  - 7a. Plants densely-tufted with crowded, erect tillers; plants resembling rice in habit; plants confined to rice fields.
    - 8a. Spikelets 3.0–3.5 mm long, usually awnless; lower lemma convex, indurate and shiny; inflorescence erect at maturity ..... *E. glabrescens*
    - 8b. Spikelets 3.5–5.0 mm long, nearly always awned, awns to 50.0 mm long; lemma of lower floret flat and scabrous; inflorescence hanging horizontally at maturity ..... *E. oryzoides*
  - 7b. Plants generally spreading, not resembling rice in habit; plants not confined to rice fields, but distributed over a wide range of wetland or irrigated habitats.

9a. Spikelets 3.0 mm or less long, broadly ovate to ovate, awnless, regularly arranged on branches of inflorescences; inflorescence erect ..... *E. colona*

9b. Spikelets 3.0 mm or more long, awned.

10a. Spikelets with staminate lower florets, anthers generally more than 1.2 mm long; inflorescence with widely spaced, more or less erect branches, branches with only a few long bristles ..... *E. paludigena*

10b. Spikelets lacking stamens in lower florets, anthers in fertile florets to 1.0 mm long; inflorescence with variably spaced, more or less spreading branches, branches with many to several long bristles.

11a. Inflorescences strongly drooping at maturity, as much as 180 degrees; spikelet awns obviously curved, never more than 15.0 mm long, usually much shorter ..... *E. crus-pavonis*

11b. Inflorescences often nodding but not strongly drooping at maturity; awns slightly curved or straight, of variable length, up to 60.0 mm long.

12a. Spikelets elliptical, to 5.0 mm long, with prominent spreading bristles; spikelets usually with abundant, long awns, awns 10.0–25.0 (–60.0) mm long; leaf sheaths hispid or ciliate with prominent papilla-based hairs or papillose only ..... *E. walteri*

12b. Spikelets broadly ovate to ovate, 3.0–4.0 mm long, awns 3.0–50.0 mm long, (abundant or scattered throughout the whole inflorescence, or sometimes confined to spikelets at the ends of the inflorescence branches); leaf sheaths usually glabrous ..... *E. crus–galli*

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ANNOTATED DISTRIBUTION OF THE MONOTYPIC GENUS *LINDHEIMERA* (ASTERACEAE: HELIANTHEAE)

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ABSTRACT

The monotypic genus *Lindheimera*, based upon *L. texana*, a common spring-flowering annual with the common name, Texas Star, occurs in mostly heavy clay or silty-clay soils of Central Texas and closely adjacent Oklahoma and the state of Coahuila, Mexico. A single record from the state of Arkansas is believed to have been introduced. A map showing the distribution of this species is provided, along with the citation of representative specimens from each of the counties in which it has been collected.

KEY WORDS: Asteraceae, *Lindheimera*, Texas, Oklahoma

RESUMEN

El género monotípico *Lindheimera*, basado en *L. texana*, es una planta frecuente anual de floración primaveral, de nombre vulgar Estrella de Texas (Texas Star), que vive normalmente en suelos calcáreos del centro de Texas y en Oklahoma, así como en el estado de Coahuila, México. Una única cita del estado de Arkansas se cree que se trata de una planta introducida. Se ofrece un mapa que muestra la distribución de la especie junto con la cita de los especímenes representativos de cada uno de los condados en que ha sido colectada.

Lindheimera texana A. Gray & Engelman is a common annual herb of central Texas and adjacent Oklahoma, occurring mostly in heavy clay or silty-clay soils. The genus name commemorates Ferdinand Lindheimer, an early botanist of central Texas who made many collections while residing in New Braunfels, Comal County, Texas (Geiser 1937). The genus contained but a single species until 1880 when Asa Gray proposed a second species from south central Mexico which he called *Lindheimera mexicana* A. Gray. Almost immediately thereafter (in 1882), he referred the latter to the newly erected genus *Dugesia* A. Gray where it has been retained by most workers, including the present (Turner, in prep.), although Stuessy (1977) retained both taxa in *Lindheimera*.

Lindheimera superficially resembles *Dugesia*, but the latter is readily distinguished by its perennial habit and prostrate stems (vs annual and stiffly erect) and free achenes (vs achenes with basal attachments to adjacent palea, these falling as a unit), and base chromosome number of $\underline{x} = 18$ (vs $\underline{x} = 8$ in *Lindheimera*). Controversies regarding the possible generic alignments of the two genera are briefly reviewed by Hind (1990). He also has provided an excellent descriptive

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account, along with illustrations (including both habit and detailed floral drawings) made from living material. According to Hind, the plant has been in cultivation at Kew for more than 20 years. He also notes that in its natural habitat the species tends to flower in early spring (March to May), but in cultivation at more northern latitudes it generally flowers between July and August, as was earlier noted by Asa Gray, who cultivated the plant in the Cambridge Botanical Garden at Harvard.

While Hind and others have commented casually upon the distribution of *Lindheimera texana*, no one has attempted to provide a detailed, documented, distributional account of the species, although a rather crude undocumented mapping was provided by Turner & Johnston (1957). The purpose of the present paper, then, is to provide a more detailed documented account of its natural distribution.

MATERIALS

This study is based upon approximately 389 specimens on deposit at the following herbaria (numbers in parenthesis refer to the sheets on loan): GH (38), LL (30), OKL (80), SMU (114), TAES (45), TEX (82). We are grateful to the directors of these institutions for the loan of material.

RESULTS

Distributional results (by county, cf. appendix, specimens cited), are presented in Fig. 1. The great mass of the borrowed material was obtained from grassland habitats of central Texas, mostly occurring in heavy calcareous clays or silty-clay soils. The species is also relatively abundant in south central Oklahoma where it occurs in similar habitats (cf. also Taylor and Taylor, 1991). The collection of a single plant from Benton Co., Arkansas (*Demaree 55532* BRIT/SMU) is surely a chance roadside introductant, although Smith (1988), commenting upon the collection concerned, notes that "several typically Texas plants have been collected in this area." The rather isolated collections of *Lindheimera texana* from Payne County, Oklahoma (cited below) might also be an introduction. Only a single collection is known from Mexico (as cited), but this area is poorly collected, especially during the springtime, although it is possible that the collection concerned is also a chance introduction.

APPENDIX

Representative specimens examined: U.S.A. OKLAHOMA. **Caddo Co.**: 10 mi W of Apache, 3 Jun 1954, *Waterfall 11934* (GH, OKL, TEX). **Carter Co.**: Criner Hills, 1.5 mi NE of Brock, 31 May 1968, *Goodman 7852* (OKL). **Comanche Co.**: McKenzie Hill, Ft. Sill Army Base, 2 May 1989, *Thompson et al. S0302* (OKL). **Harmon Co.**: 14 mi S of Erick, 25 May 1940, *Waterfall 2001* (OKL). **Jackson Co.**: 7.8 mi W of jct 62 and 283, 19 Apr 1975, *Barber 658* (OKL). **Jefferson Co.**: N of Red River bridge, 22 Apr 1957, *Rohrbaugh 497* (OKL). **Johnston Co.**: 0.8 mi W of Wapanucka, 25 Apr 1971, *Perino & Williams 695* (OKL). **Love Co.**: Rte. 32, 1.8 mi W of I-35,

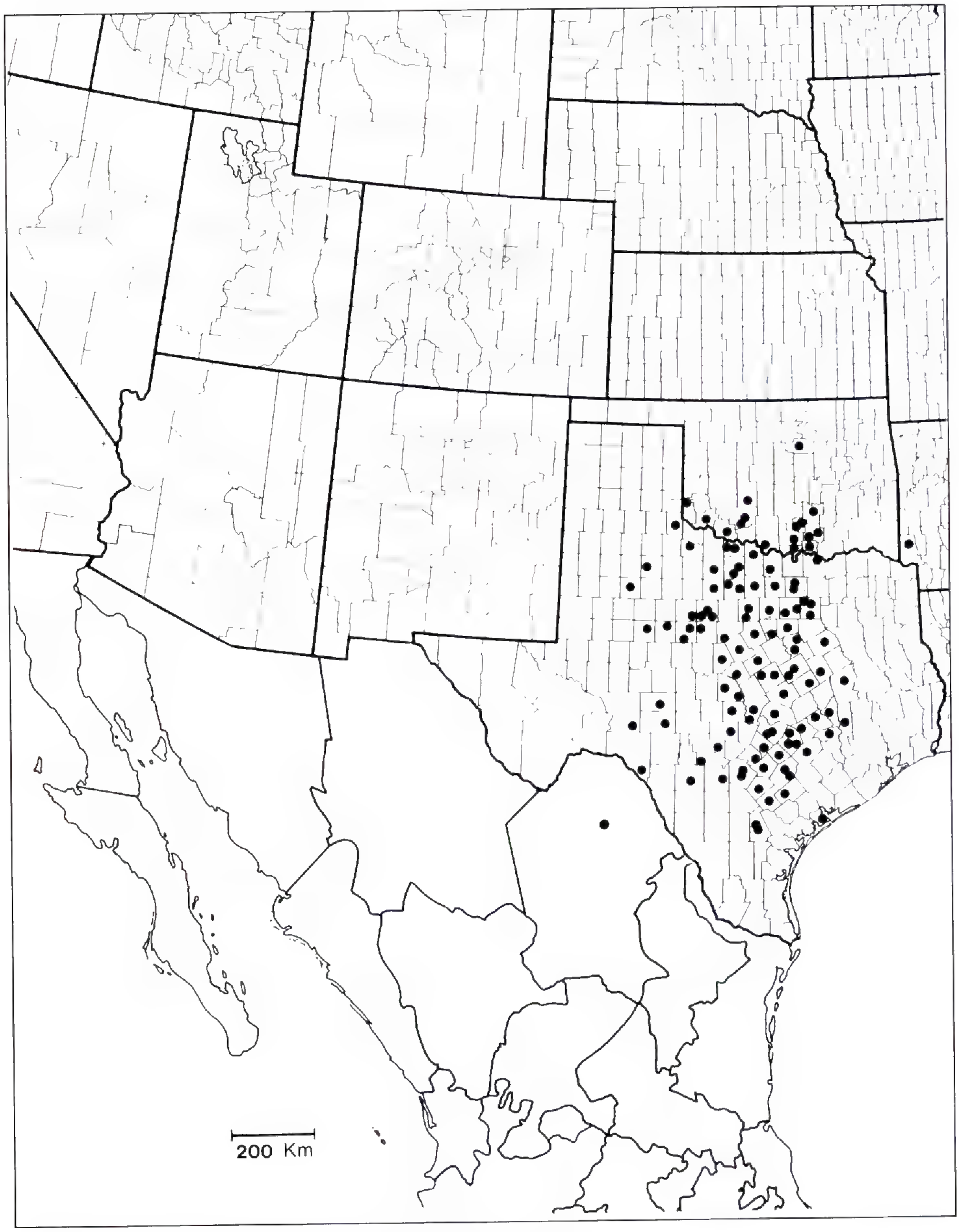

FIG. 1. Documented occurrence of *Lindheimera texana*.

3 May 1980, *Huft 1023* (OKL). **Marshall Co.:** 3 mi W of Kingston, 19 Jun 1968, *Johnson 297* (OKL). **Murray Co.:** Arbuckle Mts., 3 mi W of Doughtery, 2 May 1940, *Hopkins et al. 1100* (GH, LL, OKL, TEX). **Payne Co.:** 1 mi W of Stillwater, 16 Jun 1938, *McLean 146* (TEX). **Pontotoc Co.:** 1.5 mi S of Ada, 28 Apr 1948, *Robbins 2957* (OKL). **Tillman Co.:** 4.5 mi S of Hollister, 5 Jun 1948, *Waterfall 7818* (GH, OKL, TEX).

TEXAS. **Archer Co.:** 4 mi N of Olney, 8 Apr 1966, *Seigler 887* (OKL). **Bandera Co.:** 2 mi N of Utopea, Mar 1965, *Ramirez & Cardenas 41* (TEX). **Bastrop Co.:** 5 mi E of Elgin, 1 Apr 1984,

Steck & Berger 8401 (TEX). **Baylor Co.**: S of Seymour, 26 May 1932, *Clark 4688* (OKL). **Brazos Co.**: 1 mi E of Benchley, 1 May 1941, *Timmons s.n.* (TAES). **Brown Co.**: 5 mi E of Bangs, 17 Apr 1966, *Johnson 64* (OKL). **Burleson Co.**: 3 mi N of Caldwell, 26 Apr 1958, *Filer 114* (TAES). **Caldwell Co.**: Chesser Farm, 18 Apr 1964, *Chesser s.n.* (TEX). **Calhoun Co.**: Indianola, *Pope s.n.* (GH). **Callahan Co.**: 0.5 mi E of Taylor Co. line, 27 Mar 1963, *Henderson 63-81* (TEX). **Childress Co.**: Childress, 19 Apr 1932, *Tharp s.n.* (TEX). **Comal Co.**: Comanche Spring, New Braunfels, Mar 1850, *Lindheimer 945* (GH, Okl). **Dallas Co.**: White Rock Lake, 23 Apr 1940, *Lundell & Lundell 8537* (GH, LL). **Denton Co.**: Clear Creek near Bolivar, 30 Jun 1969, *Brown 26* (OKL). **De Witt Co.**: western part of county, 29 Apr 1942, *Riedel s.n.* (GH, TEX). **Eastland Co.**: Rising Star, 21 Apr 1931, *Smith s.n.* (TEX). **Erath Co.**: college farm road in Stephenville, 20 Apr 1962, *Haile s.n.* (TAES). **Grimes Co.**: 9 mi S of Navasota, 11 Apr 1951, *Chang 36* (TAES). **Fayette Co.**: just W of city limits of La Grange, 10 Apr 1954, *Turner & Johnston 54318* (TEX). **Foard Co.**: 7 mi N of Crowell, 11 Apr 1966, *Turner 15* (LL, TAES). **Garza Co.**: 7.4 mi E of Post, 2600 ft, 11 Apr 1966, *Hutchins 1039* (LL). **Gonzales Co.**: 6 mi NW of Hochheim, 11 Apr 1964, *Gentry & Smith 20543* (LL). **Grayson Co.**: 1 mi NE of Denison, 14 Jun 1948, *Gentry 301* (TEX). **Guadalupe Co.**: 7 mi SW of Seguin, 10 Jul 1973, *Patterson 170* (LL). **Hays Co.**: intersection of RR 12 and 214 (Hugo Rd.), 27 Mar 1986, *Lemke 395* (TAES). **Hill Co.**: 0.8 mi E of McCown, Valley State Park, 20 Apr 1986, *Nesom 5404* (TEX). **Johnson Co.**: Hwy 67, 1 mi S of Cleburne, 14 Apr 1957, *Chambers 1116* (LL). **Karnes Co.**: 14.7 mi from jct with Hwy 181 at Karnes City, 19 Apr 1957, *Chambers 11823* (LL). **Kerr Co.**: 4.2 mi E of Hunt, 16 Apr 1957, *Rollins & Chambers 15917* (LL). **Lee Co.**: 1.4 mi NW of Lexington, 14 Apr 1967, *Lonard 1842* (TAES, TEX). **Leon Co.**: 3 Jun 1954, *Tharp et al. 54989* (TEX). **Limestone Co.**: 6.5 mi S of Thornton, 20 Apr 1957, *Correll et al. 16088* (LL). **Llano Co.**: 10 mi W of Llano, 14 Apr 1950, *Gould et al. 5497* (TAES, TEX). **McCulloch Co.**: 3 mi SE of Brownwood, 26 Apr 1966, *Horne 13* (LL, TAES). **Mills Co.**: 20 mi W of Goldthwaite, 22 May 1972, *Briggs 318* (TAES). **Mitchell Co.**: Colorado, 17 May 1902, *Tracy 7888* (TEX). **Montague Co.**: 8.3 mi W of Bowie, 19 Apr 1968, *Janne 163* (TAES). **Navarro Co.**: Corsicana, Mar 1933, *Homblin s.n.* (TEX). **Nolan Co.**: Sweetwater, 29 Apr 1931, *Tharp 35* (TEX). **Palo Pinto Co.**: 0.5 mi E of Strawn, 11 Jun 1955, *Gould 6845* (TAES, TEX). **Parker Co.**: Weatherford, 27 Jun 1931, *Shaw 43* (TEX). **San Saba Co.**: Leonard ranch, 10 mi S of Richland Springs, 26 Mar 1966, *Calhoun 12* (LL, TAES). **Schleicher Co.**: 9 1/3 mi S of Eldorado, 27 Apr 1942, *Cory 39005* (TEX). **Shackelford Co.**: SW corner of county, 30 Mar 1959, *Correll 20578* (LL). **Tarrant Co.**: 2.5 air mi SW of Benbrook, 15 May 1948, *Cory 54452* (LL). **Taylor Co.**: 1 mi E of Hwy 277 on Hwy 1086, W of Bradshaw, 6 Apr 1963, *Mahler 3174* (TEX). **Throckmorton Co.**: 10 mi N of Throckmorton near headquarters of TAES Ranch, 30 Apr 1960, *Gould 9113* (TAES). **Travis Co.**: ca. 0.5 mi NE of Loop 360 bridge over Barton Creek, 19 Apr 1989, *Orzell & Bridges 9333* (TEX). **Val Verde Co.**: 0.5 mi E of dam, 20 mi NNW of Del Rio, 31 Mar 1947, *McVaugh 7735* (GH, TEX). **Washington Co.**: 30 Mar 1938, *Brackett s.n.* (TEX). **Wichita Co.**: 15 mi NW of Wichita Falls, 5 Jun 1976, *Higgins 100304* (TEX). **Young Co.**: 15 mi NE of Throckmorton, 8 May 1960, *McCoy 3772* (OKL).

MEXICO. COAHUILA: Muzquiz, 5 Dec 1936, *Marsh 1051* (TEX).

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BOOK NOTICES

PATTERSON, WILMA. 1990. **A Fountain of gardens. Plants and Herbs of the Bible**. (ISBN: 0-87951-461-2, hbk). The Overlook Press, Lewis Hollow Road, Woodstock, New York, NY 12493. $35.00. 160 pp.

This book describes the important plants mentioned in the old and new testaments (Bible). The plants illustrated are arranged in an alphabetical manner. There are about 70 full color illustrations. This book also discusses the recipes for cosmetics, herbal cures, potpourris and foods, as well as hints on growing some of the plants. There are a bibliography, picture sources and an index. This book will be useful for those who find the scriptures important for religious reasons, for those who enjoy plants and finding new uses for them, and those who get pleasure from the pictures of a bygone age which the bible portrayed.—*Krishna Puttaparthi.*

STEVENS, M. P. 1991. **The Botanical Literature of Mississippi.** Museum Technical Report 12. (pbk). Mississippi Museum of Natural Science, 111 North Jefferson Street, Jackson, MS 39202. Price unknown. 50 pp.

This spiral-bound book gives bibliographic data for and indexes to 327 references on Mississippi botany, including plants *sensu stricto* with fungi and soils thrown in for good measure. The five indexes are to scientific and common names, geographic localities, plant communities, subjects, and authors. Only a few states have similar guides. This is a fine model.—*John W. Thieret.*

VASEY, DANIEL E. 1992. **An Ecological History of Agriculture. 10,000 B.C.–A.D. 10,000.** (ISBN 0-8138-0909-6, hbk). Iowa State University Press, Ames, IA 50010. $34.95. 363 pp.

This book describes the past and present agricultural systems and looks at the future possibilities. Chapter 1 addresses the ecological approach. Chapter 2 describes the origins of agriculture. Chapter 3 discusses the overview of pre-industrial agriculture. Chapter 4 describes the pastoralism. Chapters 5 and 6 discuss the tropics, dry lands, and dry summer lands. Chapter 7 describes the humid temperate lands. Chapter 8 addresses the population and agriculture. Chapter 9 examines the rise of industrial agriculture. Chapter 10 describes the industrial agriculture to the present. Chapter 11 surveys the special problems of developed countries and the possible role of agriculture in solving them. The final chapter addresses the future. There is a glossary and an index. This book could be used by anthropologists, geographers, agricultural historians and others concerned with agriculture and its history.—*Krishna Puttaparthi.*

DOCUMENTED CHROMOSOME NUMBERS 1993:1. CHROMOSOME NUMBER REPORTS IN COMPOSITAE WITH EMPHASIS ON TRIBE ASTEREAE OF THE SOUTHWESTERN UNITED STATES AND MEXICO

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ABSTRACT

A total of 78 counts for 64 taxa of Compositae are presented. Of these, five are for previously uncounted taxa: *Grindelia camporum* var. *bracteosa* ($n = 12$), *G. confusa* ($n = 6$), *Isocoma tenuisecta* ($n = 6_{II}, 12_{II}$), *Conoclinium betonicifolium* ($n = 10_{II}$), and *Gnaphalium schraderi* ($n = 14_{II}$). Three counts are reports of previously unreported ploidy levels for the taxa they represent. Two counts are of interest because they conflict with earlier reports: *Geissolepis suaedaefolia* ($n = 9_{II}$) and *Vanclevea stylosa* ($2n = 12$).

RESUMEN

Se presentan un total de 78 recuentos para 64 taxa de Asteraceae. De estos, cinco pertenecen a taxa que no habían sido recontados previamente: *Grindelia camporum* var. *bracteosa* ($n = 12$), *G. confusa* ($n = 6$), *Isocoma tenuisecta* ($n = 6_{II}, 12_{II}$), *Conoclinium betonicifolium* ($n = 10_{II}$), y *Gnaphalium schraderi* ($n = 14_{II}$). Tres recuentos ofrecen niveles de ploidía no citados previamente para los taxa afectados. Dos recuentos son de interés porque están en contradicción con recuentos previos: *Geissolepis suaedaefolia* ($n = 9_{II}$) y *Vanclevea stylosa* ($2n = 12$).

In this paper, we report 78 chromosome counts for 64 taxa of Compositae representing the tribes Astereae, Eupatorieae, Heliantheae, Inuleae and Tageteae. The chromosome numbers of five of these taxa were previously unknown, and three of our counts appear to be reports of additional ploidy levels for taxa reported earlier. The numbers obtained for two species in this study differ from the single previous reports in each case; these are discussed below.

As observed by Ralston et al. (1989), it is becoming increasingly difficult to discover whether or not newly obtained chromosome counts previously have been reported. However, to the best of our knowledge (all standard plant chromosome number indices and the computerized BIOSIS® database have been searched) the counts reported here as new are new, and the others are in agreement with the information in various reference works. Conversion of the data contained in the several printed indices into a machine-readable and -searchable database is much to be desired. As was noted by Strother (1972), biosystematic studies are enhanced by knowledge of variation in chromosome number within and between

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taxa, but the flood of such information is becoming increasingly difficult to encompass without computer assistance.

METHODS AND MATERIALS

Voucher specimens for all counts are deposited at COLO, KANU, RM or TEX, as noted in Table 1. Chromosome squashes, if prepared by the standard acetocarmine technique, were made from buds field-collected into 3:1 EtOH: acetic acid and subsequently stored at minus 20°C in 70% EtOH. Buds for squashes made using the FLP method of Jackson (1973) were collected into 3:1 EtOH:propionic acid; subsequent storage was similar. Permanent reference slides were made in all cases and are on file at KANU; those of acetocarmine squashes were preserved in Hoyer's medium, and those of FLP squashes in Canada balsam diluted with propionic acid (Jackson 1973). All collections are those of MAL; counts were made by JL and MAL. Micrographs (Fig. 1) were made on an Olympus compound microscope at a magnification of ×1000 (phase-contrast, oil immersion) using 4×5 Polaroid P/N55 film.

DISCUSSION

Astereae—Most of the counts for the 41 taxa of this tribe (Table 1) are consistent with the present state of knowledge about the base chromosome numbers of the genera. *Grindelia camporum* var. *bracteosa* ($n = 12_{II}$), *G. confusa* ($n = 6_{II}$), and *Isocoma tenuisecta* ($n = 6_{II}, 12_{II}$) were uncounted prior to this study.

New ploidy levels are reported for three taxa. Counts for *Erigeron strigulosus* and *Isocoma rusbyi* appear to represent tetraploids relative to the previously reported

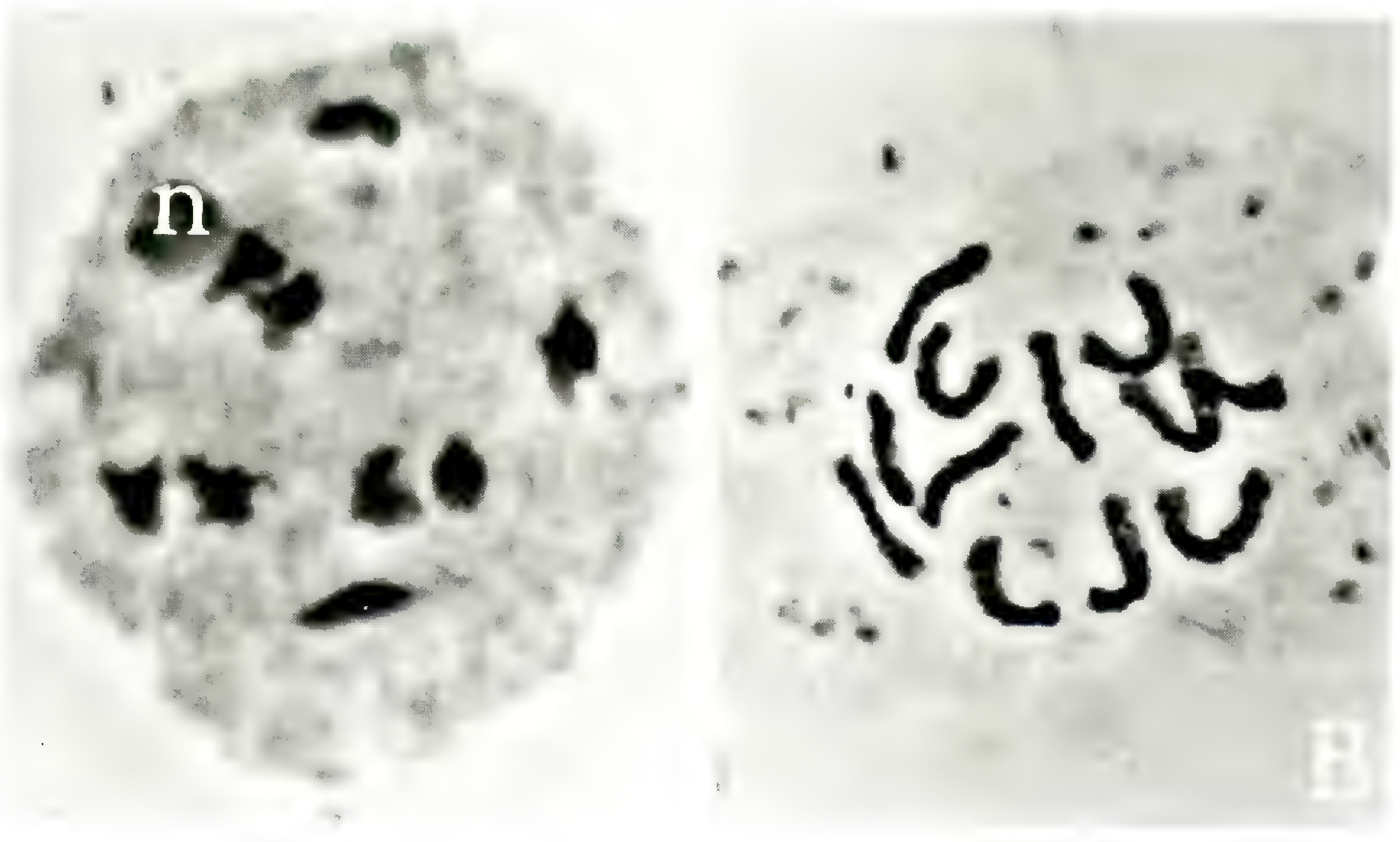

FIG. 1. A. *Geissolepis suaedaefolia* pollen parent cell showing nine pairs of chromosomes (n = nucleolus). B. *Vanclevea sytlosa* mitotic cell with twelve chromosomes.

Table 1. Chromosome counts for 64 taxa of Compositae. All counts were made from meiosis (usually diplotene) in pollen parent cells except as noted. Collection numbers are those of MAL; vouchers are deposited as indicated by herbarium acronym. * = Taxon previously unreported. ** = Previously unreported ploidy level. *** = Count differs from previous reports. † = Meiosis irregular: most cells had 10 bivalents, a ring of 4, and 4 supernumerary chromosomes.

Taxon	Gametic chromosome number	Voucher (repository)
ASTEREAE		
Aphanostephus ramosissimus DC. var. *humilis* (Benth.) Turner & Birdsong	4_{II}	Mexico: San Luis Potosi: 2.3 mi N of Las Tablas, *2914* (TEX)
Aphanostephus skirrhobasis Trel.	3_{II}	Texas: Bastrop Co.: 6 mi SE of Bastrop, *3239* (KANU)
Croptilon hookerianum House var. *graniticum* (E. B. Smith) E. B. Smith	7_{II}	Texas: Burnet Co.: Inks Lake State Park, *3233* (KANU)
Ericameria arborescens E. Greene	9_{II}	California: Contra Costa Co.: Univ. of California Botanic Garden, *3260* (KANU)
Erigeron delphinifolius Willd.	9_{II}	Mexico: Durango: 26.5 km N of El Piño, *2733* (TEX)
****Erigeron strigulosus*** E. Greene	18_{II}	Mexico: Chihuahua: 11.1 km S of La Junta, *2501* (TEX)
******Geissolepis suaedaefolia*** Robinson	9_{II}	Mexico: San Luis Potosi: 0.7 mi N of Las Tablas, *2911* (TEX)
Grindelia camporum E. Greene var. *camporum*	6_{II}	California: Kern Co.: jct. of IH5 and CA hwy 46, *3097* (KANU); Los Angeles Co.: Elizabeth Lake Rd. 0.25 mi E of Green Valley Rd., *3094* (KANU); Fresno Co.: Tranquillity, along Fresno River, *3100* (KANU)
Grindelia camporum E. Greene var. *camporum*	12_{II}	California: San Luis Obispo Co.: jct. of US101 and CA hwy 58, *3098* (KANU); Merced Co.: CA hwy 165 at San Joaquin River, *3102* (KANU); Santa Clara Co.: Pacheco Pass, E of San Felipe, *3103* (KANU); Contra Costa Co.: Pinole, along San Pablo Blvd., *3104* (KANU)
***Grindelia camporum* E. Greene var. *bracteosa* (J. Howell) M. A. Lane	12_{II}	California: Los Angeles Co.: seaward edge of Pepperdine Univ. campus, *3092* (KANU); San Benito Co.: Parkfield grade, 2.2 mi from CA hwy 198, *3251* (KANU)
Grindelia confusa Steyerm.	6_{II}	Mexico: Durango: 23.2 km W of Guadalupe Victoria on hwy 40, *2276* (TEX); 12.3 km W of Guadalupe Victoria on hwy 40, *2273* (TEX)
Grindelia camporum E. Greene × *G. stricta* DC. var. *angustifolia* (A. Gray) M. A. Lane	12_{II}	California: Solano Co.: CA hwy 37, W of CA hwy 29 and NE of Napa R. bridge, *3105* (KANU)
Grindelia hirsutula Hook. & Arn. var. *hallii* (Stey.) M. A. Lane	6_{II}	California: San Diego Co.: 2.7 mi E of Julian, *3088* (KANU)
†*Grindelia hirsutula* Hook. & Arn. var. *davyi* (Jepson) M. A. Lane	$10_{II}+R4+4ß$	California: Madera Co.: Nippanawasee, along CA hwy 49, *3101* (KANU)

Table 1. (continued)

Taxon	Gametic chromosome number	Voucher (repository)
Grindelia hirsutula Hook. & Arn. var. *davyi* (Jepson) M. A. Lane	12_{II}	California: Colusa Co.: 4.5 mi E of College City, *3107* (KANU); 2 mi E of Colusa on CA hwy 20, *3108* (KANU)
Grindelia squarrosa (Pursh) Dunal var. *serrulata* (Rydberg) Steyerm.	6_{II}	Colorado: Moffatt Co.: Dinosaur Nat. Mon., Deerlodge CG on Yampa R., *2933* (COLO)
Grindelia stricta DC. var. *angustifolia* (A. Gray) M. A. Lane	12_{II}	California: Solano Co.: CA hwy 37, Napa R. bridge, *3106* (KANU)
Grindelia stricta DC. var. *platyphylla* (E. Greene) M. A. Lane × G. *nana* Nutt.?	12_{II}	California: Humboldt Co.: Humboldt Redwoods St. Park, Mattole Rd., *3136* (KANU)
Grindelia stricta DC. var. *stricta*	12_{II}	Washington: Clallam Co.: Sequim, *3145* (KANU)
Gutierrezia microcephala DC.	16_{II}	Mexico: Nuevo Leon: 38 km E of Saltillo on hwy 40, *2583* (TEX)
Gutierrezia sarothrae (Pursh) Britt. & Rusby	4_{II}	California: San Diego Co.: 2.7 mi E of Julian, *3089* (KANU)
Haplopappus gracilis (Nutt.) A. Gray	2_{II}	Colorado: Archuleta Co.: ca. 20 mi W of Pagosa Springs, hwy 160, *2976* (COLO); New Mexico: Doña Ana Co.: 25.1 mi NE of Deming, hwy 26, *3078* (KANU)
Heterotheca grandiflora Nutt.	9_{II}	California: San Diego Co.: CA hwy 94 at Otay Lakes Rd., *3085* (KANU)
Heterotheca subaxillaris Britton & Rusby	9_{II}	Florida: Escambia Co.: Pensacola, *3241*, *3242* (KANU)
Isocoma acradenia (E. Greene) E. Greene var. *eremophila* (E. Greene) Nesom	12_{II}	California: San Diego Co.: 7.9 mi E of Julian, *3090* (KANU)
Isocoma hartwegii (A. Gray) E. Greene	6_{II}	Mexico: San Luis Potosi: 23 km E of San Luis Potosí, *2925* (TEX)
****Isocoma menziesii* (Hook. & Arn.) Nesom var. *menziesii*	6_{II}	California: San Diego Co.: Marron Valley Rd., 5.4 mi S of CA hwy 94, *3087* (KANU)
	12_{II}	California: San Diego Co.: Marron Valley Rd., 5.1 mi S of CA hwy 94, *3086* (KANU)
Isocoma menziesii (Hook. & Arn.) Nesom *vernonioides* (Nutt.) Nesom	12_{II}	California: San Benito Co.: 5 mi S of var. Panoche Rd. on New Idria Rd., *3254* (KANU)
Isocoma pluriflora (Torrey & A. Gray) E. Greene	12_{II}	New Mexico: Valencia Co.: jct. of IH25 and NM hwy 6, *3075* (KANU); Texas: Hudspeth Co.: 10 mi E of El Paso on IH10, *3079* (KANU)
****Isocoma rusbyi* E. Greene	12_{II}	Arizona: Gila Co.: jct. IH10 and Riggs Rd., *3082* (KANU)
***Isocoma tenuisecta* E. Greene	6_{II}	New Mexico: Hidalgo Co.: 15 mi E of AZ state line on IH10, *3081* (KANU)

Table 1. (continued)

Taxon	Gametic chromosome number	Voucher (repository)
	12_{II}	Arizona: Cochise Co.: 6 mi S Cochise on Cochise Rd., *3083* (KANU)
Lessingia filaginifolia (Hook. & Arn.) M.A. Lane var. *filaginifolia*	5_{II}	California: Contra Costa Co.: Univ. of California Botanic Garden, *3258* (KANU)
Lessingia leptoclada A. Gray	5_{II}	California: Contra Costa Co.: Univ. of California Botanic Garden, *3256* (KANU)
Lessingia nemaclada E. Greene	5_{II}	California: San Benito Co.: Parkfield grade, 10.4 mi from CA hwy 198, *3250* (KANU)
Lessingia occidentalis (H.M. Hall) M.A. Lane	5_{II}	California: San Benito Co.: Parkfield grade, 10.4 mi from CA hwy 198, *3249* (KANU)
Machaeranthera pinnatifida (Hook.) Shinners var. *chihuahuana* B. Turner & R.L. Hartman	4_{II}	Mexico: Nuevo Leon: Estación Mariposa, *2885* (TEX); San Luis Potosi: 23 km E of San Luis Potosi, *2934* (TEX)
Pityopsis aspera (Shuttlew.) Small var. *adenolepis* (Fern.) Semple & Bowers	18_{II}	Florida: Escambia Co.: ca. 1 mi W of Pensacola, *3243* (KANU)
Prionopsis ciliata (Nutt.) Nutt.	6_{II}	Texas: Cooke Co.: US hwy 135 at Red River, *2586* (TEX); New Mexico: Doña Ana Co.: 25.1 mi NE of Deming, hwy 26, *3077* (KANU)
Stenotus armerioides Nutt.	9_{II}	New Mexico: Taos Co.: Carson NF Tres Piedras RS, *3073* (RM)
Stephanodoria tomentella Robinson & Greenman	6_{II}	Mexico: San Luis Potosi: Las Tablas, *2920* (COLO)
******Vanclevea stylosa*** (Eastw.) E. Greene	$2n = 12$	Utah: Kane Co.: Glen Canyon NRA, Paria Canyon RS, *3247* (KANU)
Xanthisma texana DC.	4_{II}	Texas: Calhoun Co: Swan Point, near Seadrift, *2811* (TEX)
EUPATORIEAE		
Conoclinium betonicifolium (Miller) King & H. Robinson	10_{II}	Mexico: San Luis Potosi: Las Tablas, *2921* (TEX)
Stevia serrata Cav.	44_{I}	Mexico: Mexico: 18.2 km W of Toluca, *2647* (TEX)
HELIANTHEAE		
Acmella radicans (Jacq.) R. K. Jansen var. *radicans*	39_{II}	Mexico: Sinaloa: 41 mi E of Mazatlan on hwy 40, *2154* (TEX)
Bahia aristata (Rydb.) Turner	10_{II}	Mexico: San Luis Potosi: 1.3 mi S of Colonia Libertad, *2909* (TEX)
Bidens odorata Cav. var. *oaxacensis* Ballard	12_{II}	Mexico: Oaxaca: Cd. Oaxaca, *2103* (TEX)
Cosmos caudatus Kunth	24_{II}	Mexico: Guerrero: 27 mi S of Chilpancingo on hwy 95, *2132* (TEX)
Cosmos sulphureus Cav.	12_{II}	Mexico: Guerrero: 27 mi S of Chilpancingo on hwy 95, *2131* (TEX).
Galinsoga parviflora Cav.	16_{II}	Mexico: Veracruz: 14.5 km W of Mendoza on hwy 150, *2067* (TEX)

Table 1. (continued)

Taxon	Gametic chromosome number	Voucher (repository)
Melampodium divaricatum (Rich) DC.	12_{II}	Mexico: Oaxaca: Cd. Oaxaca, *2105* (TEX)
Melampodium microcephalum Less.	12_{II}	Mexico: Sinaloa: 41 mi E of Mazatlan on hwy 40, *2153* (TEX)
Parthenium confertum A. Gray var. *microcephalum* Rollins	17_{II}	Mexico: Nuevo Leon: Estación Mariposa, *2886* (TEX)
Sigesbeckia hartmanii B. Turner	15_{III}	Mexico: Michoacan: 16 km S of Quiroga, *2435* (TEX)
Simsia lagascaeformis DC.	17_{II}	Mexico: Oaxaca: Cd. Oaxaca, *2104* (TEX)
Tridax coronopifolia (Kunth) Hemsley	27_{II}	Mexico: Mexico: 6.2 km E of rd. to Tula on hwy 51D, *2400* (TEX)
Viguiera potosina Blake	17_{II}	Mexico: San Luis Potosi: Las Tablas, *2919* (TEX)
Zaluzania parthenioides (DC.) Rzedowski	18_{II}	Mexico: San Luis Potosi: 1.3 mi S of Colonia Libertad, *2908* (TEX)
Zinnia haageana Regal	12_{II}	Mexico: Michoacan: 52.6 km W of Morelia, *2408* (TEX)
Zinnia peruviana (L.) L.	12_{II}	Mexico: Zacatecas: 19.3 km toward Tlaltenango from Jalpa, *2447* (TEX)
INULEAE		
**Gnaphalium schraderi* DC.	14_{II}	Mexico: Oaxaca: 48 mi NW of Cd. Oaxaca on hwy 190, *2108* (TEX)
Tageteae		
Nicolletia trifida Rydb.	10_{II}	Mexico: Baja California Sur: 22.8 km N of Loreto on hwy 1, *2365* (TEX)
Tagetes lucida Cav.	11_{II}	Mexico: Michoacan: 52.6 km W of Morelia, *2407* (TEX)
Thymophylla setifolia (Lag.) Strother var. *setifolia*	13_{II}	Mexico: Puebla: 13 mi SW of jct. hwys 150D and 28, *2085* (TEX)

diploids (Keil et al. 1988; Solbrig et al. 1964). We obtained a diploid count of $n = 6_{II}$ for *Isocoma menziesii* var. *menziesii*, although the previous count (Pinkava & Keil 1977) and one of ours were tetraploid.

The count obtained here for *Geissolepis suaedaefolia*, $n = 9_{II}$, differs from that reported by Ralston et al. (1989). Those authors reported $n = 8_{II}$, and discussed the distinctiveness of *Geissolepis* (a monotypic genus) among American Astereae. They suggested that it perhaps resembles *Astranthium* and *Aphanostephus* in receptacle and achenial trichome characters, and in chromosome number, assuming that the $n = 8$ represented a tetraploid on a base of $x = 4$ (present in both *Astranthium* and *Aphanostephus*). However, the squashes we observed clearly revealed nine pairs of chromosomes at diplotene and diakinesis (Fig. 1A). With respect to this count, it is interesting that *Dichaetophora campestris* has $n = 3_{II}$ (Turner & Ellison 1960; Watson 1973) or $n = 6_{II}$ (Sundberg et al. 1986), and that it shares the peculiar hooked achenial hairs of *Geissolepis*, among other features.

Nesom (pers. comm.) suggests that *D. campestris* would be better placed as a species of *Astranthium* derived via dysploid reduction from $x = 4$. A cpDNA analysis of these and other genera suggested to be related (e.g. *Chaetopappa, Leucelene, Egletes*, etc.) by Shinners (1946) is warranted.

Solbrig et al. (1964) reported a count of $n = 9_{II}$ (which was, according to a footnote, "calculated from somatic counts") for *Vanclevea stylosa*. Given the morphological resemblance of this taxon to *Petradoria* and *Hesperodoria* (=*Haplopappus* sect. *Hesperodoria*), this count did not seem out of place. However, phylogenetic analysis of chloroplast DNA restriction site mutations (Lane & Jansen 1990; Lane, unpubl. data) place this taxon within a clade having $x = 6$. Our count of $2n = 12$, and careful observation of technical characters such as disk corolla shape and style-branch appendages support the indication that *Vanclevea* may be a member of the "$x = 6$ group" of Astereae (Hartman & Lane 1991; Lane 1983), perhaps near *Xylorhiza* and/or *Pyrrocoma*, rather than of the "$x = 9$ group." Additional phylogenetic analyses currently underway may clarify this point.

Eupatorieae—The count of $n = 10_{II}$ for *Conoclinium betonicifolium* is new but unremarkable within the genus.

Heliantheae—All sixteen counts obtained for members of this tribe confirm previous reports.

Inuleae—*Gnaphalium schraderi* is here reported for the first time as $n = 14_{II}$, which is consonant with the known base chromosome number of that genus.

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NOTES

CREPIS ZACINTHA (ASTERACEAE), ADVENTIVE IN TEXAS, AND THE FIRST RECORD IN NORTH AMERICA—A roadside weed, *Crepis zacintha* (L.) Babc., new to Texas and new to North America (Kartesz, in press) was recently collected from Waller County, Texas. A key to the four species of *Crepis* in Texas and a description and an illustration of *C. zacintha* are included.

In April 1992, the junior author collected a weedy plant at the base of a state highway department gravel mound along old highway 90 west of Brookshire in Waller Co., Texas. The initial observation revealed the weed a member of the tribe Lactuceae of the family Asteraceae. Its predominantly basal, lyrate-pinnatifid leaves; paniculate inflorescence; small heads; phyllaries of two-size classes; naked receptacle; yellow ligules; 10-ribbed, unbeaked fruits; and white, capillary, deciduous pappus bristles suggested the specimen belonged to the genus *Crepis* L. It differed, however, from the three *Crepis* species reported from Texas, i.e., *C. capillaris* (L.) Wallr., *C. pulchra* L., & *C. runcinata* (James) Torr. & Gray (Correll & Johnston 1970, Hatch et al. 1990, Johnston 1990) in several characters, especially in the mature inner phyllaries being indurate, strongly angular, completely enclosing fruits and also in fruit apices being almost bent at right angles.

The authors speculated the weed to be an adventive species, possibly from the Old World. The senior author identified it to *Crepis zacintha* (L.) Babcock in the Asteraceae treatment by P.D. Sell in the 4th volume of *Flora Europea* (Tutin et al. 1976). Although Sell's description of *Crepis* section *Zacintha* (Miller) Babcock and of *C. zacintha* applied well to the specimen, his description neither mentioned the indurate nature of the mature inner phyllaries nor the bent apices of the fruits. Since these characters appeared to be diagnostic, there was some doubt about the identity of the specimen. However, we found that Babcock's (1947, pp. 760–762) detailed description of *C. zacintha* accounted well for each aspect of the specimen.

KEY TO THE SPECIES OF *CREPIS* IN TEXAS

1. Inflorescence dichotomously cymose with some heads sessile at or near bifurcations, the other heads pedunculate; mature inner phyllaries indurate, strongly angular with the upper half nearly horizontal, completely enclosing fruits and pappus, more or less fused with the fruit pericarp; principal leaves (excluding bracteal ones) basal or nearly so at anthesis ..... *C. zacintha*

1. Inflorescence various, but all heads pedunculate; mature inner phyllaries reflexed; principal leaves basal or cauline at anthesis 2
   2. Principal leaves basal or subbasal; perennials with woody or fleshy caudex ..... *C. runcinata*
   2. Principal leaves cauline; annuals with no permanent caudex 3

3. Stem base with glandular and eglandular hairs; pappus rather persistent; plants present in E Texas ..... *C. pulchra*
3. Stem base glabrous or with eglandular hairs; pappus caducous; plants present in the Trans-Pecos area of Texas ..... *C. capillaris*

Crepis zacintha (L.) Babcock, Univ. Calif. Publ. Bot. 19:404. 1941. (Fig. 1).

Lapsana zacintha L., Sp. Pl. 2: 811. 1753. *Rhagadiolus zacintha* (L.) Desf., Fl. Pedem. 1:227. 1785. *Zacintha verrucosa* Gaertn., Fruct. 2:358. 1791.

Annuals, lactiferous, 20–30 cm high; stems usually branched above or near base, pubescent below, glabrous above. Leaves basal and cauline; basal leaves lyrate-pinnatifid with the terminal segment the largest, pubescent, 10–20 cm long and 2–4 cm wide; cauline leaves similar to the basal ones, but smaller, sessile, and auriculate, the lower and median ones deciduous, the upper ones bracteal. Inflorescence dichotomously cymosely branched, with some heads sessile at or near bifurcations, and other heads peduncled; peduncles fistulose, 1–3 cm long. Heads many, ligulate. Involucre 5–7 mm long, 3–7 mm wide, of two series; outer phyllaries 5, unequal, the longest one ca. half the length of the inner phyllaries, glabrous or tomentulose at the base; inner phyllaries 10, lanceolate, obtuse, ciliate at apex, glabrous or tomentulose at base; lower half of each inner phyllary becoming indurate after anthesis, strongly angular, with the upper half nearly horizontal, completely enclosing fruits and pappus, more or less fused with the fruit pericarp. Receptacle naked. Flowers ca. 30, bisexual; corolla yellow or yellow on the inner surface and purplish-red on the outer surface, 5-toothed, pubescent, the tube ca. 1.4 mm long, the ligule ca. 5.6 mm long and 1.2 mm wide; anthers ca. 2.8 mm long; style branches ca. 1 mm long. Fruits yellowish, with their apices bent at almost a right angle, often dimorphic: marginal fruits, if present, laterally strongly compressed, 2–2.5 mm long, glabrous or pubescent; inner fruits subterete, ca. 2.5 mm long, 10-ribbed. Pappus of 8–15, white, capillary bristles, ca. 1.5 mm long, deciduous (description adapted from Babcock).

Specimen observed from the NEW WORLD: **U.S.A.** TEXAS. Waller Co.: state hwy department gravel mound along old U.S. 90, ca 1/2 mi W of Brookshire and across hwy from roadside park, 18 Apr 1992, *L.E. Brown 15947* (NCU, SBSC).

Specimen observed from the OLD WORLD: GREECE. Thessaly, below Kastanea, toward Kalabaka, 8 Jul 1930, *Babcock 349*; Hort. Genet. California (US!; grown from seeds collected by Babcock).

Crepis zacintha is a native of the Mediterranean region. We are uncertain regarding the mode of the introduction of this species to Texas, since we have found no record of its existence anywhere else in North America.

Because of its unique morphology, Hoffmann (in Engler & Prantl 1897, p. 360) recognized *C. zacintha* in the monotypic genus *Zacintha* P. Miller as *Z. verrucosa* Gaertn. However, Babcock (l.c.) asserted that its close relationship with *C. dioscoridis* L., justified its disposition in *Crepis*.

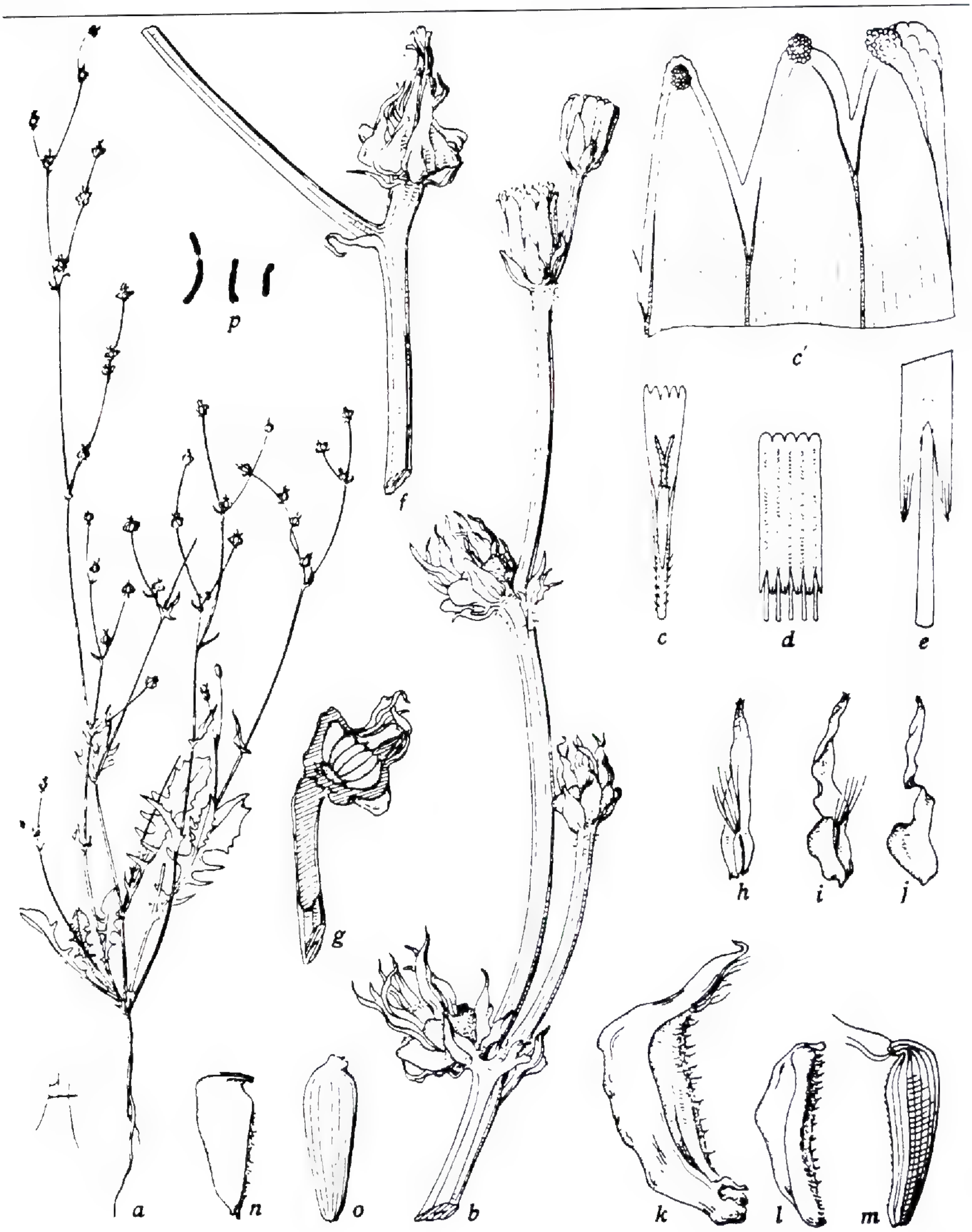

FIG. 1. *Crepis zacintha* (From: Babcock 1947, with permission).

ACKNOWLEDGMENTS

The authors thank: Dr. R. Dale Thomas (NLU) and Dr. Guy Nesom (TEX) for their helpful comments on the manuscript; the curators of NCU and US for the loan of some specimens of *C. zacintha*; and the University of California Press

at Berkeley for permission to use the illustration of *C. zacintha* from Babcock's work.

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TUTIN, T.G. (Ch. Ed.) 1976. Flora Europea, vol. 4. Cambridge University Press, Cambridge, U.K.

CHAMAESYCE VELLERIFLORA (EUPHORBIACEAE) NEW TO TEXAS AND U.S.A.

While conducting field surveys of the botanical resources of eleven United States Navy properties in South Texas during 1991–1992, the senior author encountered a plant species new to his experience. The junior author, who is familiar with the *Chamaesyce* of northern Mexico, identified a specimen as *Chamaesyce velleriflora* (K.l. & Gke.) Millsp. (*Euphorbia velleriflora* (Kl. & Gke.) Boiss. This species was not reported in Wheeler's (1941) treatment of the genus *Chamaesyce* (as *Euphorbia* subgenus *Chamaesyce*) for the USA and Canada exclusive of Hawaii and southern Florida, the *Manual of Vascular Plants of Texas* (Correll & Johnston 1970), the latest update to that manual (Johnston 1990), *Checklist of the Vascular Plants of Texas* (Hatch et al. 1990), or the *Flora of the Texas Coastal Bend* (Jones 1977).

The matlike growth, semiprostrate stems, opposite leaves, and interpetiolar stipules of *C. velleriflora* identify it as a member of *Chamaesyce*, which has often been included in *Euphorbia*. In Correll & Johnston (1970), *C. velleriflora* would key (in *Euphorbia*) to couplet 64 or higher; of the available choices, its characteristic branching and cyathium arrangement of modified laterals bearing dense elongate clusters of cyathia are closely similar to *C. stictospora* (Engelm.) Small. From the latter *C. velleriflora* differs in its styles branches, from 1/2 to 2/3 bifid versus entire or briefly bifid in robustness, with cyathia greater than 1.2 mm tall, gland

appendages manifest and much wider than the gland, and in seed surfaces more nearly smooth versus shallowly pitted.

In June 1992 *C. velleriflora* was locally common in exposed, well-drained, hard-packed, caliche/gravel roadbase on an unshaded perimeter road on Naval Air Station Chase Field in Bee County. The gently rolling topography in this area is underlain by the Lissie Formation (Pleistocene); soils are mostly sandy loam Alfisols which support a mosaic of live oak woodlands and midgrass grasslands. Within the installation, seeded non-native grasses (*Bothriochloa* and *Dichanthium* spp.) dominate the landscape; associates of *C. velleriflora* on the roadbase were mostly weedy native species. In Mexico, *C. velleriflora* can often be found growing in hard-packed caliche-bearing road shoulders and ditches. The weedy nature of *C. velleriflora* in its native range in addition to its subtropical distribution, suggest it is probably a recent introduction and may not be a persistent member of the Texas flora. Collections at the University of Texas Plant Resources Center herbarium (TEX-LL) indicate that the nearest populations to the Bee County, Texas site are ca. 150 miles to the southwest along the highway from Nuevo Laredo to Monterrey in Tamaulipas.

These surveys were conducted by the Texas Natural Heritage Program of the Texas Parks and Wildlife Department under contract with the United States Navy. The assistance of Mr. Tom Burst of Southern Division Naval Facilities Engineering Command and Mr. Lee Harbison of the Public Works Department, NAS Chase Field, is gratefully acknowledged.

Voucher specimen: TEXAS. **Bee Co.**: locally common in well drained gravelly roadbase, unshaded margin of non-native *Bothriochloa-Dichanthium* grassland, perimeter rd on E side of Naval Air Station Chase Field, ca. 1.1 road mi E of front gate, elev. 190 ft, Beeville East 7.5' Quadrangle, 282237N, 973920W, 10 Jun 1992, *W. R. Carr 12029* (BRIT/SMU, TEX-LL).

—William R. Carr, Texas Natural Heritage Program, Texas Parks and Wildlife Department, 3000 IH-35 South, Austin, TX 78704, U.S.A.; Mark H. Mayfield, Department of Botany, University of Texas at Austin, Austin, TX 78713, U.S.A.

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CAREX BLANDA AND *KYLLINGA ODORATA* (CYPERACEAE) NEW TO NEW MEXICO AND A SIGNIFICANT RANGE EXTENSION OF *CYPERUS RETRORSUS*—Two predominantly eastern sedges, *Carex blanda* Dewey and *Kyllinga odorata* Vahl, previously unreported for New Mexico, have been found on Ghost Ranch. In addition, *Cyperus retrorsus* Chapm. [*C. ovularis* (Michx.) Torr. var. *cylindricus* (Ell.) Torr.] was found on the ranch. Ghost Ranch is located on the eastern slope of the Continental Divide, NW of Espanola in Rio Arriba County in T24N, R4E, Sect. 1 and is at an elevation of about 2000 m (6600 ft).

Carex blanda Dewey, section *Laxiflorae* Kunth, was reported from Quebec, Canada to North Dakota and southward to Alabama and Texas by Mackenzie (1935). Mackenzie cited specimens and mentioned *C. blanda* from Oklahoma but not New Mexico. Since then, several authors have mirrored Mackenzie's distribution (Fernald 1950, Correll and Johnston 1970, Correll and Correll 1972, Godfrey and Wooten 1979). Martin and Hutchins (1980) also did not report it for New Mexico. Bryson (1980) mapped its distribution, based on herbarium specimens, from Wyoming, south and eastward to Texas, and northern Florida, but did not find herbarium specimens from New Mexico. This suggests that *C. blanda* may be a recent introduction.

This distinct taxon should not be confused with any other caric-sedge in the New Mexico flora. It is the only member of section *Laxiflorae* represented in New Mexico. Plants are caespitose with short to elongate, fibrous roots. Culms are up to ca. 5 dm tall and usually lax. The staminate spike overtops or is proximate to the first pistillate spike. There are 3–4 pistillate spikes per culm with 4–18 perigynia per spike. The perigynia are obovoid and obtusely trigonous, ascending, with raised veins, and short, but prominent, abruptly bent beaks.

Voucher specimen. NEW MEXICO. **Rio Arriba Co.:** in moist area near stream from Box Canyon on Ghost Ranch, NW of Espanola, 19 May 1992, *Ubelaker 2529* (BRIT/SMU, ctb = pers. herb. of Charles T. Bryson, TAES).

Kyllinga odorata [*Cyperus sesquiflorus* (Torr.) Mattf. & Kükenth.] was not reported for New Mexico by Correll and Correll (1972), Godfrey and Wooten (1979), nor Martin and Hutchins (1980). We recognize the genus *Kyllinga* as separate from the genus *Cyperus* as did Tucker (1987). *Kyllinga* and *Cyperus* are readily separated based on 1–(infrequently 2–) achenes per spikelet; rachilla not or rarely elongate; and scales conduplicate, conspicuously keeled opposed to (1–) 3-many achenes per spikelet; rachilla elongate; and scales broadly rounded respectively. Inflorescences of *Kyllinga odorata* are frequently whitish, at least when fresh, and consist of 1–3 compact lobes. The central lobe can be 1.5 cm long with the side lobes reaching half that length. Achenes are lenticular and moderately to strongly truncate apically. The only *Cyperus* known in New Mexico

with lenticular achenes are *C. flavicomus* Michx. (*C. albomarginatus* Mart. & Schrad.), *C. rivularis* Kunth [*C. niger* R. & P. var. *capitatus* (Britt.) O'Neill], and *C. laevigatus* L., which should not be confused with *Kyllinga odorata*.

Voucher specimen. NEW MEXICO. **Rio Arriba Co.**: along Box Canyon stream on Ghost Ranch, NW of Espanola, 22 Jul 1991, *Ubelaker 2303A* (TAES).

Cyperus retrorsus was first reported new for New Mexico by Kessler (1984), under the name *C. ovularis* var. *cylindricus*, from the south-central part of the state near Las Cruces in Dona Ana County. The discovery of *C. retrorsus* in Rio Arriba County is a range extension of approximately 440 air km (275 mi) north and slightly east from its previously reported station.

Voucher specimen. NEW MEXICO. **Rio Arriba Co.**: along Box Canyon stream on Ghost Ranch, NW of Espanola, 22 Jul 1991, *Ubelaker 2303* (BRIT/SMU, ctb, TAES).

We thank Richard Carter (VSC), Gretchen D. Jones, J.K. Wipff (TAES), and anonymous reviewers for helpful comments improving this manuscript.

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GODFREY, R.K. and J.W. WOOTEN. 1979. Aquatic and wetland plants of southeastern United States. monocotyledons. The University of Georgia Press, Athens, GA.

KESSLER, J.W. 1984. *Cyperus ovularis* (Michx.) Torr. var. *cylindricus* (Ell.) Torr. (Cyperaceae) new to New Mexico. Sida 10:258.

MACKENZIE, K.K. 1935. Cyperaceae. *Cariceae*. North Amer. flora 18:259.

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POLYGONUM STRIATULUM (POLYGONACEAE) NEW TO THE POST OAK SAVANNAH VEGETATION AREA OF TEXAS—*Polygonum striatulum* Robins. is a rhizomatous perennial herb with a stout woody crown. The leaf blades are prominently striate-veined with short petioles. A conspicuous horizontal line (a zone of abscission) is near the middle of the petiole. Correll and Johnston (1970) consider this plant a coastal south Texas endemic, rare and local in Brooks and Kleberg counties that blooms from (April) May-July. Jones (1982) lists this taxon in the Coastal Bend area which is situated just north of Correll and Johnston's report. Jones reports *P. striatulum* as occasional on sand or clay in prairies and openings or along roads. He also adds that it is endemic to south Texas, and flowers from April to December. Hatch et al. (1990) list *P. striatulum* as occurring in regions 2 (Gulf Prairies and Marshes) and 6 (South Texas Plains).

Correll and Johnston (1970) state that *P. camporum* Miesn. and *P. brasiliense* Koch have been erroneously applied to *P. striatulum*. After examining specimens from BRIT/SMU and TAES, and photocopies of herbarium labels from TEX-LL, we agree with their statement but conclude that frequently the names *P. camporum* and *P. brasiliense* also have been misapplied to *P. texense* M. C. Johnston. *Polygonum texense* is a Texas endemic of region 7 (Edwards Plateau) and the southern part of regions 8 (Rolling Plains) and 9 (High Plains). However, Hatch et al. (1990) list *P. texense* as a synonym of *P. striatulum*, but failed to include its distribution with *P. striatulum*.

The range of *P. striatulum* is extended by approximately 265 air km (165 mi) NE from its previously known northeasterly station in San Patricio County. This new location is at the SW corner of Langsberg Road and TX 159, ca. 6 km (3.7 mi) SW of Cochran in Austin County placing it in the vegetational area region 3 (Post Oak Savannah). The collection site was in an open hayed prairie with loamy fine sand textured soil of the Kenney soil series at an elevation of ca. 53 m (175 ft). The geology of the site is of the Lissie Formation (Ql) (Pleistocene). Associated taxa include *Sorghastrum nutans* (L.) Nash, *Sorghum halepense* (L.) Pers., *Tridens albescens* (Vasey) Woot. & Standl., *T. strictus* (Nutt.) Nash, *Paspalum setaceum* Michx., *P. floridanum* Michx., *Setaria parviflora* (Poir.) Kerguelen [sy=*S. geniculata* (Lam.) P. Beauv.], and *Liatris* sp.

Voucher specimen: TEXAS. **Austin Co.:** SW corner of Langsberg Road and TX 159, ca. 6 km (3.7 mi) SW of Cochran, 2 Oct 1992, *Jones 9703* & *Griffin* (BRIT/SMU, PAUH, SAT, SWT, TAES, TEX).

—*Stanley D. Jones, S.M. Tracy Herbarium, Department of Rangeland Ecology and Management, Texas A&M University, College Station, TX 77843-2126 U.S.A. and Richard W. Griffin, Cooperative Agricultural Research Center, Prairie View A&M University, P.O. Drawer 4079 U.S.A, Prairie View, TX 77446, U.S.A.*

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HATCH, S.L., K.N. GANDHI, and L.E. BROWN. 1990. Checklist of the vascular plants of Texas. Texas Agric. Exper. Sta. Bull. MP-1655.

JONES, F.B. 1982. Flora of the Texas Coastal Bend. 3rd Ed. Welder Wildlife Foundation, contribution B-6. Sinton, TX.

SACCIOLEPIS INDICA (POACEAE) NEW TO MISSISSIPPI—*Sacciolepis indica* (L.) Chase is a native of Asia and was first reported as an introduction into the United Stated at the Government pecan orchard at Thomasville, Georgia (Hitchcock 1950). Since that time it has been reported from Florida to North Carolina (Godfrey and Wooten 1979), from Texas (Gould 1975), and from Louisiana (Allen 1992). The genus *Sacciolepis* belongs to the tribe Paniceae (Hitchcock 1950) and it is comprised of about 30 species in the tropics and subtropics in both hemispheres (Gould 1975). The closest relative of *S. indica* in the United States is *S. striata* (L.) Nash, which grows in marshes, ditches, pond margins, and other wet habitats of the Coastal Plain from New Jersey to Florida and westward to Tennessee, Texas and Oklahoma (Hitchcock 1950). *Saccciolepis indica* is a smaller (2–6 dm tall) annual than the larger (up to 1–2 m tall) perennial *S. striata*. The spikelets of *S. indica* are shorter than 3.5 mm and longer than 3.5 mm in *S. striata*.

The Mississippi collections of *S. indica* are cited below:

U.S.A. MISSISSIPPI. **Harrison Co.:** NW of Gulfport, Gulf Haven Rd, Hough Farm, T6S, R12W, S28, 20 Sep 1990, *T. C.Lockley s.n.* (SWSL); 23 Oct 1992, *T. C. Lockley s.n.* (IBE, SWSL, TAES).

At this locality, *S. indica* was found in a horse pasture with scattered pines and little woody understory and also in an adjacent open polo field. The size of the population was difficult to determine, because of periodic mowing. Associates with *S. indica* include *Anthaenatia rufa* (Ell.) Schultes, *Panicum repens* L., *P. verrucosum* Muhl., *Paspalum floridanum* Michx. var. *floridanum*, *P. setaceum* Michx. and *Rhynchospora inexpansa* (Michx.) Vahl.

ACKNOWLEDGMENTS

We thank J.K. Wipff (TAES) and Stanley D. Jones (TAES) for identification and verification of the grass species.

—*Charles T. Bryson, USDA, ARS, Southern Weed Science Laboratory (SWSL), Stoneville, MS 38776-0350 U.S.A, and Timothy C. Lockley, USDA, APHIS, S. & T., Imported Fire Ant Station, Gulfport, MS 39501, U.S.A.*

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ALLEN, C.M. 1992. *Sacciolepis indica* (Poaceae) new to Louisiana. Sida 15:154.

GODFREY, R.K. and J.W. WOOTEN. 1979. Aquatic and wetland plants of southeastern United States. University of Georgia Press, Athens, GA.

GOULD, F.W. 1975. The grasses of Texas. Texas A&M University Press, College Station, TX.

HITCHOCK, A.S. 1950. Manual of the grasses of the United States (2nd ed., revised by A. Chase). U.S. Dep. Agric. Miscellaneous Publ. Washington, D.C.

BOOK NOTICES

TAYLOR, RONALD J. 1992. **Sagebrush Country: A Wildflower Sanctuary.** (ISBN 0-87842-280-3, pbk). Mountain Press Publishing Company, P.O. Box 2399, Missoula, MT 59806. (800) 234-5308. $12.00. 221 pp.

Looking for an attractive and authoritative introduction to the plants of the sagebrush-covered areas of the west? *Sagebrush Country* includes beautiful color photographs, taken in the field, of over 200 species, with several more being described in the text. In addition, the text covers topics such as habitat preferences and adaptations, pollinators and their behavior, and the origins of the scientific names. The writing is clear, with a minimum of technical terminology; anyone who has had a high school biology course should find it a useful and enjoyable introduction to the plants of an often neglected ecosystem. In doing so, they will become aware of plants as living organisms with diverse strategies for solving the problems of survival and reproduction, not just attractive additions to the landscape. This emphasis is enhanced by the introductory paragraphs in which Taylor discusses the major vegetation zones that occur within the sagebrush country and some of the animals that frequent it.

Some amateur botanists will be dismayed to find that the photographs are arranged according to family, not flower color. They should not panic, nor give up in dismay. Taylor provides a straightforward, almost non-technical, identification key to the approximately 50 families represented in his book. This, together with the glossary and illustrations of the basic terminology used to describe flowers, will enable most wild-plant enthusiasts to identify the plants they find. Investing this effort will bring additional rich rewards for it will open the door to the identification of an even wider range of plants. Those that still find a key intimidating will discover that perusing the pictures will quickly enable them to get on "first name" terms with the many colorful plants that grow in the sagebrush ocean of western North America. In so doing, they will appreciate why Taylor describes the sagebrush country area as a "wildflower sanctuary."—*Mary E. Barkworth.*

WHARTON, M. E. and R. W. BARBOUR. 1991. **Bluegrass Land and Life.** (ISBN 0-8131-1688-0, hbk). The University Press of Kentucky, Lexington, KY 40508. $40.00. 257 pp.

The Bluegrass region of Kentucky is that area in the north central part of the state underlain by Ordovician limestone. The 2400-square-mile *Inner* Bluegrass—30% of the whole and the subject of this book—centers irregularly on Lexington; it is the thoroughbred-horse country of the state. Wharton and Barbour, eminently qualified for the task, have produced a most admirable opus covering all aspects of the region. The parts of the book are "Geology and environmental history" (geological background, presettlement vegetation and animal life, early modifications of the presettlement ecosystems), "Habitats and natural community organization" (plant communities, habitats, and present status of vertebrates), "Annotated lists" of plants and animals, and "The future of the Bluegrass." Illustrations are various maps and 32 full-page, beautiful color plates of landscapes, plants, and animals. An extensive list of literature and a detailed index are included.—*John W. Thieret.*

WELCH, WILLIAM C. 1989. **Perennial Garden Color.** (ISBN 0-87833-628-1, hbk). Taylor Publishing Company, 1550 West Mockingbird Lane, Dallas, TX 75235. $29.95. 268 pp.

This is an illustrated text on Perennial Gardens. There are over 500 beautiful color photographs. This guide gives detailed information on planting and growing 125 different perennials and more than 100 varieties of old garden roses. The book is a complete and comprehensive guide to planning and growing a beautiful and colorful garden of perennials of south. The text is divided into three parts. The first part describes the perennial garden. The second part discusses perennials of the past and present for the garden. The last part describes old garden roses and companion plants for the garden. There are an appendix, bibliography and index. This guide will be helpful for anyone interested in cottage gardening and landscaping with perennials.—*Krishna Puttaparthi.*

THE WORLD BANK. 1990. **Vetiver Grass. The Hedge against Erosion.** (ISBN 0-8213-1405-X, pbk). The World Bank, 1818 H Street, N.W., Washington, DC 20433. Price unknown. 78 pp.

This is a practical, pocket-size—but not pun-free—manual on use of the grass *Vetiveria zizanioides* as a hedge plant to control soil and water loss in tropical and subtropical areas. Having a dense root system that can grow to a depth of 3 meters and being able to withstand both drought and prolonged inundation, the plant is excellent for erosion control along contour lines in cultivated fields and on earth banks, dams, slopes, masonry terraces, roadsides, riverbanks, and canal walls. All one needs to know about growing, propagating, and using vetiver is in this book.—*John W. Thieret.*

BROSCHAT, TIMOTHY K. and ALAN W. MEEROW. 1991. **Betrock's Reference Guide to Florida Landscape Plants.** (ISBN 0-9629761-0-5, hbk). Betrock Information Systems, 1601 North Palm Avenue, Pembroke Pines, FL 33026. $67.50 (including tax/shipping & handling). 428 pp.

In this book, horticultural characteristics of some 1200 taxa, alphabetically arranged by binomial, are given under 23 headings for each taxon (e.g., growth rate, salt tolerance, soil requirements, foliage color, flowering season, propagation, major problems, drought tolerance, nutritional requirements, light requirements, and 13 others). About one-fourth of the taxa are illustrated by photographs in largely excellent color, six photos per page. Most of the illustrations are helpful in identification, some less so, and a few not at all. An index is provided to synonyms and common names. Listings of drought- and salt-tolerant plants are included. Indicated in a closing list are plants causing "environmental problems" ("messy," "weak," "weedy," "invasive"). A fine source of concise information for Florida and other warm-area gardeners, the book will be of value also for visitors to Florida interested in identifying the cultivated plants they see.—*John W. Thieret.*

Meerow, Alan W. 1992. **Betrock's Guide to Landscape Palms.** (ISBN 0-9629761-1-3, hbk). Betrock Information Systems, 1601 North Palm Avenue, Pembroke Pines, FL 33026. $34.70 (including tax/shipping & handling). 153 pp.

Meant for use throughout the tropics, and especially for Florida, California, and Hawaii, this is a concise guide to common horticultural palms. Section 1 covers 102 species, one per page. Given for each are one or more color photos, "Landscape characteristics," "Morphology (identifying characteristics)," "Comments," and sometimes "Other" or "Similar" species. Palms deserve to be illustrated well, and in this book they are. Section 2, also with many photos, considers what palms are and their growth, classification, conservation, and culture. It ends with a key based on vegetative features. Section 3 has several useful lists, e.g., drought-tolerant palms, palms that do well in shade, and growth forms. An index to common names and synonyms, a glossary, and a short bibliography close the book. Anyone interested in nature should find this splendid work a pleasure to look through; it is a must for anyone concerned with palms, "marvelous plants" as the author calls them. They are indeed.—*John W. Thieret.*

Schultes, Richard E. and Robert F. Raffauf. 1992. **Vine of the Soul.** (ISBN 0-907791-24-7, pbk). Synergetic Press, P.O. Box 689, Oracle, AZ 85623. $22.95. 282 pp.

The title *Vine of the Soul* is a translation of an Indian word, *ayahuasca*, referring to the hallucinogenic liana *Banisteriopsis caapi*. The book, an outstanding photographic essay on Indian life, emphasizes the relationship between people and plants. Documenting the work are line drawings of plants and about 160 black-and-white, beautifully reproduced photos taken mostly by Dr. Schultes between 1941 and 1961. Explanatory text accompanies each illustration.

The main sections of the book are "Plants in cosmic communication" (hallucinogens); "Payés [shamans] in the community"; "Plants of secondary importance" (e.g., medicines, stimulants, fish poisons); "Indian beliefs"; "Sacred dances"; "Abodes of spirits" (e.g., forests, mountains, rivers, caves); "Birth and contraception"; "Art and architecture"; and "Hunting and fishing rituals and plants."

That this book—a partial record of Dr. Schultes' many years of work in South America—will be of value to ethnobotanists and anthropologists goes without saying. I recommend it too for *anyone* interested in our planet and its people. Kudos to Schultes for this and his two recent companion volumes, *The Healing Forest* and *Where the Gods Reign*, both also devoted to Amazonia. A classic trio.—*John W. Thieret.*

Foster, Steven. 1991. **Echinacea. Nature's Immune Enhancer.** (ISBN: 0-89281-386-5, pbk). Healing Arts Press, One Park Street, Rochester, VT 05767. $7.95. 155 pp.

This book provides comprehensive information on the genus *Echinacea.* The text includes an introduction, the medicinal uses of *Echinacea* by the plains Indian, eclectic physicians, modern research and future potential, preparations, safety, risks vs. benefits, cultivation on the farm and in the garden, chemical constituents, its taxonomic history, characteristics of the genus, species identification and distribution and the need for conservation. It also provides sources of the plants

and seeds and emphasizes the importance of ethnobotanical conservation and the medicinal uses to treat certain infections and diseases. Included are a bibliography, an index and a few line drawings. This is a good reference for anyone interested in using herbs for medication.—*Krishna Puttaparthi.*

ERRATUM

CHUNG, M.G. and J.W. KIM. 1990. The genus *Hosta* Tratt (Liliaceae) in Korea. Sida 14:411–420.

Hosta venusta F. Maekawa, J. Jap. Bot. 11:245. 1935, is the correct name for *Hosta taquetii* (Levl. in Fedde) M. Chung & J. Kim comb. nov. (p. 415).

Funkia subcordata Sprengel var. *taquetii* Levl., Repert Spec. Nov. regni Veg. 9:322. 1911. TYPE: KOREA. PROV. CHE-JULDO. Che-ju Island, Mt. Hal-la, elev. ca. 1,700 m, 4 Aug 1910, *Taquet 4047* (HOLOTYPE: E!).

Hosta venusta var. *decurrens* F. Maekawa, J. Jap. Bot. 13:897. 1937. TYPE: KOREA. PROV. CHE-JU-DO. Che-ju Island, Mt. Hal-la, elev. ca 1,500 m, 14 Aug 1912, *Isidoya 32* (HOLOTYPE: TI!).

Hosta taquetii (Levl. in Fedde) M. Chung & J. Kim, Sida 14:415. 1990. BASIONYM: *Funkia subcordata* Sprengel var. *taquetii* Levl.

—*Myong Gi Chung, Department of Biology, Gyeongsang National University, Chin-Ju, 660-701, Republic of Korea (SOUTH).*

BOOK REVIEWS

TOMER, JOHN S. and MICHAEL J. BRODHEAD (eds.) 1992. **A Naturalist in Indian Territory. The Journals of S.W. Woodhouse, 1849–50.** (ISBN 0-8061-2476-8, hbk). University of Oklahoma Press, Norman, OK 73019. $29.95. 288 pp.

"Last night the Camp was alarmed by the horses breaking their picket pins and running furiously & snorting and it was thought by many that Indians were about," Dr. Woodhouse, physician and naturalist with the Creek-Cherokee boundary survey, was writing his journal 16 August 1850. He was then east of the Cimmaron River in Indian Territory. "There is much of a sameness in this part of the country[.] hardly a flower of any kind is to be seen." The doctor wrote the next day that "shortly after I got in bed I thought I saw an Indian skulking near the camp. I put on my shoes seized my gun and started in my shirt tails but saw nothing of him[.] this has been a tremendous hot day."

Thirty years after Thomas Nuttall had botanized in the Arkansas Territory, Samuel Washington Woodhouse (1821-1904), who had known Nuttall at the Academy of Natural Sciences in Philadelphia, is today generally identified as the author of the later "Report on the Natural History" appended to Lorenzo Sitgreaves' *Report of an Expedition down the Zuni and Colorado Rivers*. Woodhouse published eight papers on birds and mammals of the southwest in the Academy's *Proceedings*. John L. LeConte described Woodhouse's beetles; Edward Hallowell, his reptiles; and Baird and Girard, his fishes. In 1865 Asa Gray, who was then working on the Compositae for his *Synoptical Flora*, named *Achyropappus woodhousei* for the collector. Incidentally, though unidentified by these authors, Asa Gray's handwriting is illustrated by his annotation on the Woodhouse specimen of *Solidago petiolaris* (p. 41). Most of Woodhouse's surviving plant collections—originally over 1400—received by John Torrey in 1852 are now in the New York Botanical Garden Herbarium.

Authored by an ornithologist-museum curator, John Tower, in tandem with Michael Brodhead, an historian of the American West, this book will interest the student of Indian lore, the ecologist reconstructing the habitat of the buffalo hunter, or Nuttall's canebrake "still to be seen," or by the reader picturing Tallassee before it became Tulsa. Thoroughly documented and indexed, this resurrection of Woodhouse's three journals is a blend of habitats and habits. "The prairie was covered by flowers of Red, Yellow & White, forming a bouquet on a large scale[.] we got our tents pitched and had dinner at 12 N[.] in the evening we took a bath and I wrote to Aunt." That was Woodhouse in Indian Territory.

Woodhouse retired from the natural history stage in 1854 due, it is said, to declining health. He was elected to the ornithology committee of the Philadelphia Academy along with its patron Thomas B. Wilson and John Cassin (see SIDA 15 (1): 167. 1992). As a player in the bygone Audubonian Epoch Woodhouse came back on stage in his last years and was greeted at the A.O.U. meeting the year he died. A lingering question: for whom did the American Woodsman name his son, John Woodhouse Audubon?—*Joseph Ewan, Missouri Botanical Garden, P.O. Box 299, St. Louis, MO 63166-0299, U.S.A.*

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FISCHER, D. W. and A. E. BESSETTE. 1992. **Edible Wild Mushrooms of North America, A Field-to-Kitchen Guide.** (ISBN 0-292-72079-3, hbk; ISBN 0-292-72080-7, pbk). University of Texas Press, P.O. Box 7819, Austin, TX 78713-7819. (512) 471-4032. $35.00 (hbk), $19.95 (pbk). 177 color photographs, 11 line drawings, 256 pp.

This book, according to the authors, "... is specifically designed to help the beginner identify and prepare the most commonly eaten wild mushrooms of North America." Initial topics such as what is a mushroom?, mushrooms and taste, and mushrooms and nutrition, provide a background for the choice culinary delights to come. Helpful information about hunting mushrooms includes what to take, where to look, where to go, and how to pick. The mycophagist's ten commandments is a practical guide to safely enjoy eating mushrooms.

More than 100 species of edible mushrooms are represented by colored photographs, species descriptions giving key identifying characteristics, non-technical morphological descriptions, fruiting times and habitats, a section on similar, often toxic, species that may be confused with edible species, and notes on edibility. There are no microscopic morphological characteristics or chemical reactions given. If there is one weakness about this book it is the lack of a key to the various groups of edible fungi. The reader will have to leaf through the book to match the specimen at hand with the photographs and species descriptions. The colored photographs are slightly on the small size (2 3/4 by 3 3/4 inches), especially in view of the wide page margins. Some of the mushrooms illustrated include the chanterelles, gilled mushrooms, boletes, toothed mushrooms, polypores, puffballs, morels, and jelly fungi. There is a section on mushroom poisoning and poisonous wild mushrooms.

There is a special chapter on preparing, preserving and cooking wild mushrooms that will appeal to anyone interested in including mushrooms in their cuisine or gourmet meals. A special feature of this book is the 63-page section that includes 70 wild mushroom recipes. Delectable dishes are highlighted such as trumpet chanterelle omelet, meadow mushroom pie, wild mushroom gravy, stropharia cheese muffins, marinated tricholoma and pasta delight, fawn mushrooms au gratin, sautéd king boletes, puffball parmesan, baked stuffed morels, and mixed mushroom sauté (which appears on the front book cover). The recipes are accompanied by color photographs of a dinner-plate presentation that will tantalize your taste buds and make your mouth water for these mushroom dishes. If you are interested in using mushrooms in your gourmet cooking then this books falls in the "must buy" category. Bon appetit!—*Harold W. Keller*

METZLER, S. and V. METZLER. 1992. **Texas Mushrooms, A Field Guide.** (ISBN 0-292-75125-7 hbk; ISBN 0-292-75126-5, pbk). University of Texas Press, P. O. Box 7819, Austin, TX 78713-7819. (512) 471-4032. $39.95 (hbk); $17.95 (pbk). 14 illustrations, 249 color photographs, 350 pp.

Texas Mushrooms is a field guide to mushrooms in a handy small size format of 5 3/4 by 8 1/4 inches to facilitate carrying it into the field on forays. As the authors state, "This book is a pictorial guide to common Texas mushrooms and fungi." The introductory chapters, represented by 56 pages, give a general overview of the classification of fungi, how to collect and identify mushrooms and other fungi with pictorial illustrations of common terms used to describe the fruiting bodies. The pictorial keys are designed for the layperson using non-technical, descriptive terminology simply arranged in a matrix format instead of the more typical dichotomous keys. There is a brief section on mushroom toxins and on cooking and eating wild mushrooms. There is a North American Mycological Association Poison Form included for reporting mushroom

poisoning. There are some helpful hints for the picking, cleaning, and preparation of mushrooms for eating. Recipes are included for delectable dishes such as mushroom pizza, mushroom dip, mushroom soup, chanterelle quiche, chanterelle enchiladas, and deep fried mushrooms.

The next 271 pages are devoted to 26 species of *Amanita*, seven species in the Lepiotaceae, four species in the Hygrophoraceae, 26 species in the Russulaceae, 24 species in the Tricholomataceae, 32 species in the Boletaceae, and a total of over 200 species of fungi pictorially illustrated with colored photographs. For each species the edibility/poisonous designation is given when known, a brief non-technical description along with an explanation of the scientific name, comments about edibility or macroscopic morphological characters, seasonality patterns, habit, habitat and distribution. Distribution is not given by counties and it appears that most of the species come from the eastern and the southeastern half of Texas. This is understandable since the authors reside in Houston and the Texas Mycological Society holds their annual forays mostly in the Big Thicket area of Texas.

The taxa are arranged by classes, orders, families, and genera. The layout of the book consists of one species per page with the upper half text and the lower half a habit colored photograph showing the key characters of the fungus. The photographs are excellent and enable the user to picture key the fungus at hand. Microscopic characters and chemical reactions are omitted from the descriptions. There is an appendix with a spore data chart that lists the spore size, spore shape, and Melzer's reaction for each species. And finally, there are general references to field guides, reference books, technical books, and mushroom cookbooks. This book should be on the bookshelf of every Texan that loves the outdoors and wants to know more about living things that are encountered as one roams the wide open spaces of Texas.—*Harold W. Keller*

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UNA NUEVA ESPECIE DE *AGAVE* (AGAVACEAE, SUBGENERO *AGAVE*) DE OAXACA Y CHIAPAS, MEXICO

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ABSTRACT

Agave isthmensis from Oaxaca and Chiapas, México is described as new and illustrated. The new species belongs to the Hiemiflorae group. Its relationships with *A. potatorum* and *A. pygmaea*, its closest relatives are discussed.

RESUMEN

Se describe e ilustra una nueva especie, ***Agave isthmensis*** de los estados de Oaxaca y Chiapas, México. El nuevo taxon pertenece al Grupo Hiemiflorae. Se discuten sus relaciones con *A. potatorum* y *A. pygmaea*, las especies más cercanamente emparentadas.

El género *Agave* L. está constituido por aproximadamente 155 especies, 116 de las cuales (75 %) crecen en México (García-Mendoza en prensa). Centros secundarios de riqueza se hallan en el Sur de los Estados Unidos, Guatemala y Cuba. La especie aquí descrita pertenece al complejo grupo Hiemiflorae (Gentry 1982), conformado por 12 especies que se distribuyen entre los 10° y 20° de latitud Norte en los estados de Veracruz y Puebla, México a Costa Rica.

Agave isthmensis García-Mendoza & Palma, sp. nov. (Fig. 1)

Agave pygmaea Gentry affinis, sed rosula compacta, minore, foliis magis numerosis, infra scabrosis, dentibus magis approximatis, floribus majoribus, surculis rhizomatosis numerosis et florescentia dissimili differt.

Rosetas de 25–36 cm de diámetro y 17–32 cm de alto, compactas, con numerosos hijuelos rizomatosos en plantas jóvenes y de origen axilar en plantas adultas, con 84–132 hojas por roseta. Hojas de 8–10 cm de largo por 5–8 cm de ancho, ovadas, con el ápice truncado, cóncavas, suculentas, estrechándose hacia la base, escabrosas en el envés; margen profundamente crenado; dientes (2-) 3–4 mm de largo, deltoides, café-rojizos, cercanos entre sí, con menos de 1 mm de separación entre ellos; espina de 1.2–1.5 cm de largo, sinuosa, ligeramente

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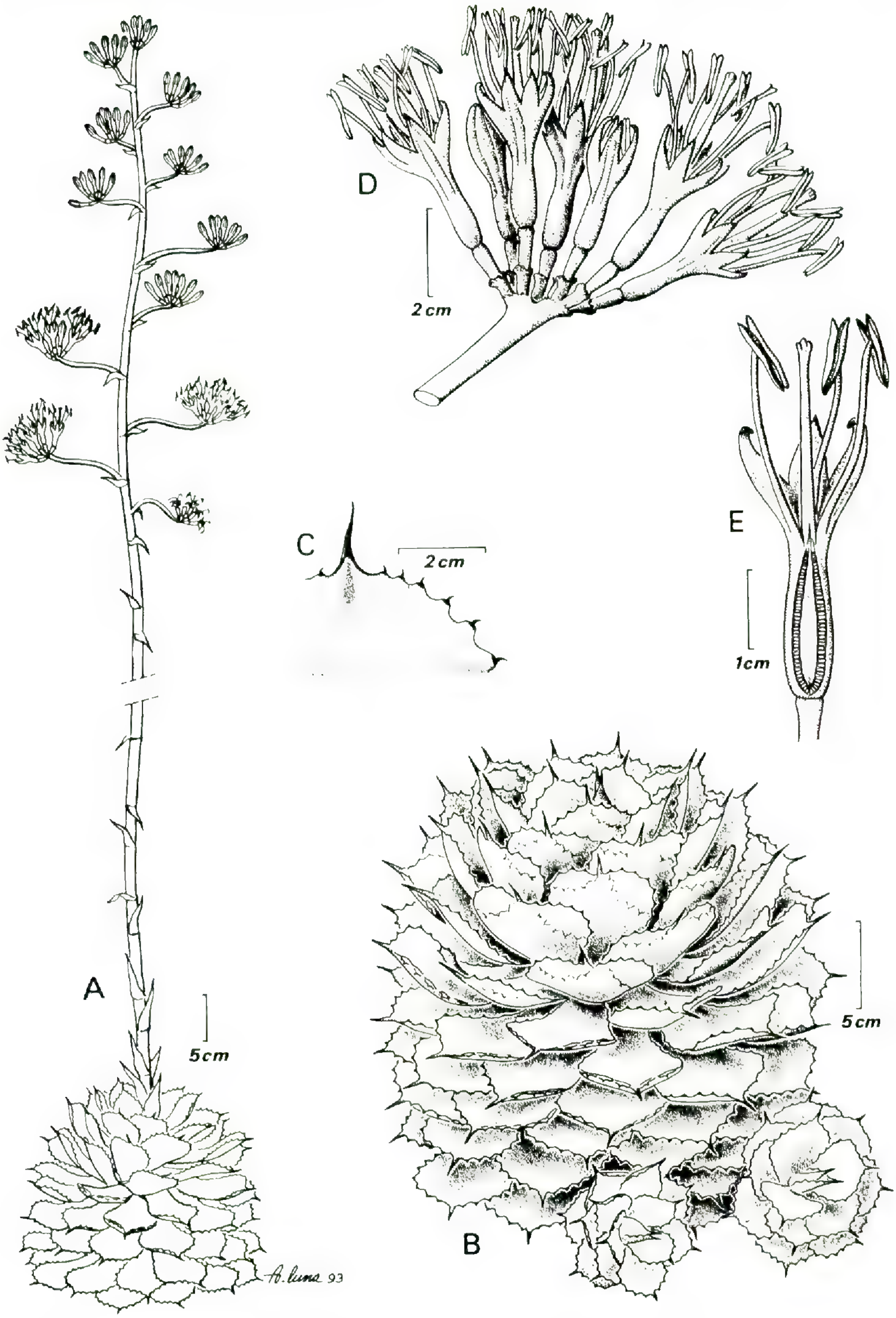

FIG. 1. *Agave isthmensis*. A) hábito; B) roseta con hijuelos rizomatosos; C) detalle del ápice truncado y del margen crenado de la hoja; D) ramilla floral; E) corte longitudinal de la flor. Ilustración basada en los especímenes *García-Mendoza & Martínez 4163* y *García-Mendoza et al. 4177*.

aplanada y decurrente en 6–10 mm por el haz, café-rojiza. Inflorescencia de 1.7–2.2 m de alto, de forma oblonga, con (6-) 20–25 ramillas florales, de 9–16 cm de largo, ubicadas en las 3/4 partes superiores del escapo; brácteas de 3.4–3.8 cm de largo por 4.5–6.9 cm de ancho, deltoides, papiráceas. Flores de 3.8–4.6 cm de largo, amarillentas, suculentas; bracteolas menores a 5 mm de largo, tempranamente caedizas; pedicelos de 3–4 mm, alargándose hasta 1 cm durante la fructificación; ovario de 1.6–2.1 cm de largo; tubo de 4–5 mm de largo, infundibuliforme, trisulcado; tépalos de 19–21 mm de largo por 4 mm de ancho, oblongos, subiguales; filamentos de 27–33 mm de largo, insertados en la base de los tépalos, amarillentos; anteras de 14–17 mm de largo, amarillentas. Cápsulas de 1.6–2.2 cm de largo por 1.0–1.8 cm de ancho, ovoides, apiculadas. Semillas de 2–4 mm de largo por 1–2 mm de ancho, aplanadas, negras.

Tipo: MEXICO. Chiapas: Municipio de Ocozocuautla, 1 km al N de Ocozocuautla, Bosque de *Quercus*, 875 m, 3 Ago 1989, *A. García-Mendoza, E. Martínez & J. Reyes* 4177 (holotipo: MEXU; isotipos: BRIT/SMU, DES, ENCB).

Especímenes adicionales examinados: MEXICO. **Chiapas**: Municipio de Ocozocuautla, 1 km al N de Ocozocuautla, 9 Jul 1989, *A. García-Mendoza* & *E. Martínez 4163* (MEXU), *A. García-Mendoza, E. Martínez & J. Reyes 4176* (MEXU) . **Oaxaca**: Distrito de Tehuantepec, 21 km al N de Laollaga, 23 Ago 1984, *R. Torres & C. Martínez 5856* (MEXU); 2 km al O de Salina Cruz, carretera a Pochutla, 19 Ago 1988, *C. Martínez 1731* (MEXU).

El Grupo Hiemiflorae ha sido caracterizado por Gentry (1982) por presentar floración invernal, racimos florales en panículas globosas y pedúnculos florales cortos. Sin embargo al estar haciendo la revisión taxonómica del grupo se ha visto que *A. isthmensis* al igual que *A. pygmaea*, *A seemanniana* y algunas formas de *A. potatorum*, presentan características no típicas de Hiemiflorae como son los pedúnculos florales largos, las panículas subglobosas y el inicio de la época de floración (excepto en *A. pygmaea*) a la mitad del otoño.

La especie aquí descrita se distingue por presentar rosetas compactas, pequeñas, con numerosas hojas glaucas, escabrosas por el envés y de dimensiones reducidas, así como por su reproducción prolifera de tipo rizomático y axilar entre las hojas. Se diferencia de *A. pygmaea* Gentry (la especie más cercanamente emparentada) por tener un mayor número de hojas, con dientes más cercanos entre sí y flores más grandes, además de la época de floración diferente (Tabla 1).

Agave isthmensis pertenece a un complejo de especies formado por *A. potatorum* Zucc., *A. seemanniana* Jacobi, además de *A. pygmaea*, taxa que presentan una gran variabilidad morfológica, aunada al gran número de ambientes que colonizan. Gentry (1982) sugiere y Ullrich (1992) establece que *A. pygmaea* debe ser ubicado en una categoría infraespecífica.

Aunque *A. isthmensis* tiene similitud con algunas formas de *A. potatorum* es posible diferenciarlo por el tamaño reducido de su roseta, hojas, inflorescencia, flores y frutos, así como por su época de floración.

Agave isthmensis crece sobre areniscas o suelos de origen calcáreo, de los 50 a los

Tabla 1. Características diferenciales entre *Agave isthmensis*, *A. pygmaea* y *A. potatorum*.

CARACTERISTICA	*Agave isthmensis*	*A. pygmaea*	*A. potatorum*
Número de hojas	84–132	25–40	50–80 (-100)
Tamaño de hojas	8–10 × 5–8 cm	12–28 × 7–12	25–40 × 9–18
Hijuelos rizomáticos	presentes en plantas muy jóvenes	ausentes	ausentes
Hijuelos axilares	presentes en plantas adultas	ausentes	ausentes
Envés de la hoja	escabroso	liso	liso
Separación entre dientes	3–6 (-9) mm	10 mm	10–30 mm
Longitud total de las flores	38–46 mm	31–35 mm	55–80 mm
Epoca de floración	julio a septiembre	septiembre enero	diciembre

900 msnm en selvas bajas caducifolias y bosques cálidos de *Quercus*, donde forma densas colonias de más de 50 rosetas, originadas clonalmente a partir de pocos individuos.

El epíteto específico se refiere a su área de distribución, limitada al Istmo de Tehuantepec, en los estados de Oaxaca y Chiapas, México.

AGRADECIMIENTOS

Agradecemos la revisión del manuscrito a Fernando Chiang (MEXU), Raquel Galván (ENCB) y tres revisores asignados por el Comité Editorial de la revista. La ilustración es aportación de Albino Luna (Instituto de Biología de la U.N.A.M.) y la diagnosis en latín fue hecha por Fernando Chiang.

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ERUCASTRUM GALLICUM (BRASSICACEAE): INVASION AND SPREAD IN NORTH AMERICA

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ABSTRACT

The invasion and spread of the European *Erucastrum gallicum* (Brassicaceae) in North America are traced from the first collection, in 1903, through 1992. The plant is now known from 29 states of the United States and from all provinces and one territory of Canada. The increasing North American range, shown on four maps, indicates a spot-and-fill pattern of spread.

RESUMEN

La invasión y expansión poblacional de la especie europea *Erucastrum gallicum* (Brassicaceae) en Norte América se rastrea desde la primera colección (1903) hasta 1992. La planta se ha encontrado en 29 estados de los Estados Unidos y en todas las provincias y un territorio del Canadá. El acrecentamiento del ámbito en Norte América, demostrado en cuatro mapas, indica un modelo de expansión poblacional de "spot-and-fill."

Although it is recognized that invasion of biological communities by alien species is important both economically and ecologically, few data exist on invasion patterns of plants in North America. When such patterns are known (e.g., Barbour and Rodman 1970; Forcella and Harvey 1988; Mack 1981; Stuckey 1979, 1980a, 1980b, 1985; Stuckey and Phillips 1970), the point(s) of original introduction can be determined and the route(s) of subsequent dispersal traced. This type of information is valuable for predicting possible outcomes of future invasions whether these are accidental or deliberate.

About 20% of the 5500 species of vascular plants in the flora of northeastern United States and adjacent Canada–the "Gray's Manual range" (Fernald 1950)–are aliens, and most of these are from Eurasia. This Eurasian element is positively associated with human disturbance and can comprise up to 73% (Baker 1986), or even more, of the species found in some biological communities. Understanding the invasion process requires an understanding of how plants interact with human activities.

In this paper we document the invasion and spread of *Erucastrum gallicum*

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(Willd.) O.E. Schulz (dog mustard, French dog mustard) in North America. This species, a Eurasian import, appeared in the Gray's Manual range early in the 20th century. Dog mustard is a widespread species with narrow habitat requirements. Because it is limited to specific habitat types, it can be considered a "minor weed" (sensu Baker 1974) and may offer a special opportunity to assess how the activities of people can facilitate plant invasion.

IDENTIFICATION AND ECOLOGY OF *ERUCASTRUM GALLICUM*

Certainly no mustard in North America is easier to identify than *E. gallicum* (Fig. 1), with its bracteate proximal pedicels, which are unusual in the family (Masters 1875). This feature alone separates the species from most other mustards in its North American range. Nevertheless, we have seen specimens of the plant misidentified as *Arabidopsis thaliana*, *Brassica nigra*, *B. rapa*, *Diplotaxis erucoides*, *D. muralis*, *D. tenuifolia*, *Rorippa curvisiliqua*, *Sisymbrium auriculatum* (= *Coelophragmus auriculatus*), *S. incisum* (= *Descurainia incana* subsp. *incisa*), *S. irio*, *S. loeselii*, and *S. officinale*. Misidentifications of dog mustard persist into the 1990s even though *E. gallicum* is now included in many U.S. and Canadian floras.

Erucastrum gallicum is a summer annual, or rarely a winter annual (Klemow and Raynal 1983) or a biennial (Gleason and Cronquist 1963). The plants grow in sparsely vegetated habitats, most commonly along railroads and roadsides and in waste ground (see also Rollins 1981). They are characterized by high reproductive output and a persistent seed bank (Klemow and Raynal 1983). This species differs from many other weedy annuals in that only a small percentage of seeds in the seed bank germinates in any year. Such a life history trait apparently buffers the effects of year-to-year climatic variation and allows population persistence, but may also limit the potential of this species to become weedy (Klemow and Raynal 1983).

EARLY INVASION AND CURRENT DISTRIBUTION

The first published report of dog mustard (as *E. pollichii*) for North America is that of Robinson (1911). The voucher specimen, in the Gray Herbarium (GH), bears only scant data: "W. Finger, Milwaukee [Wisconsin], recd. 1905." Supplemental data, apparently received by Robinson from William Finger himself and included in Robinson's paper, indicate that the specimen was collected in 1903 "along the tracks of a suburban electric line, just beyond the city-limits of Milwaukee." The manner of introduction of the seed is unknown, but Milwaukee, although an inland city, has been a port of entry since the mid 1800s for ships from Europe and elsewhere (Mabee 1961).

That Robinson did not report dog mustard as "adventive" in North America until 1911 explains why the species was not included in the 1908 edition of *Gray's manual* (Robinson and Fernald 1908). Curiously, it was also not included in the 1913 edition of the Britton & Brown flora (Britton and Brown 1913).

Our herbarium search revealed three additional collections made in the first

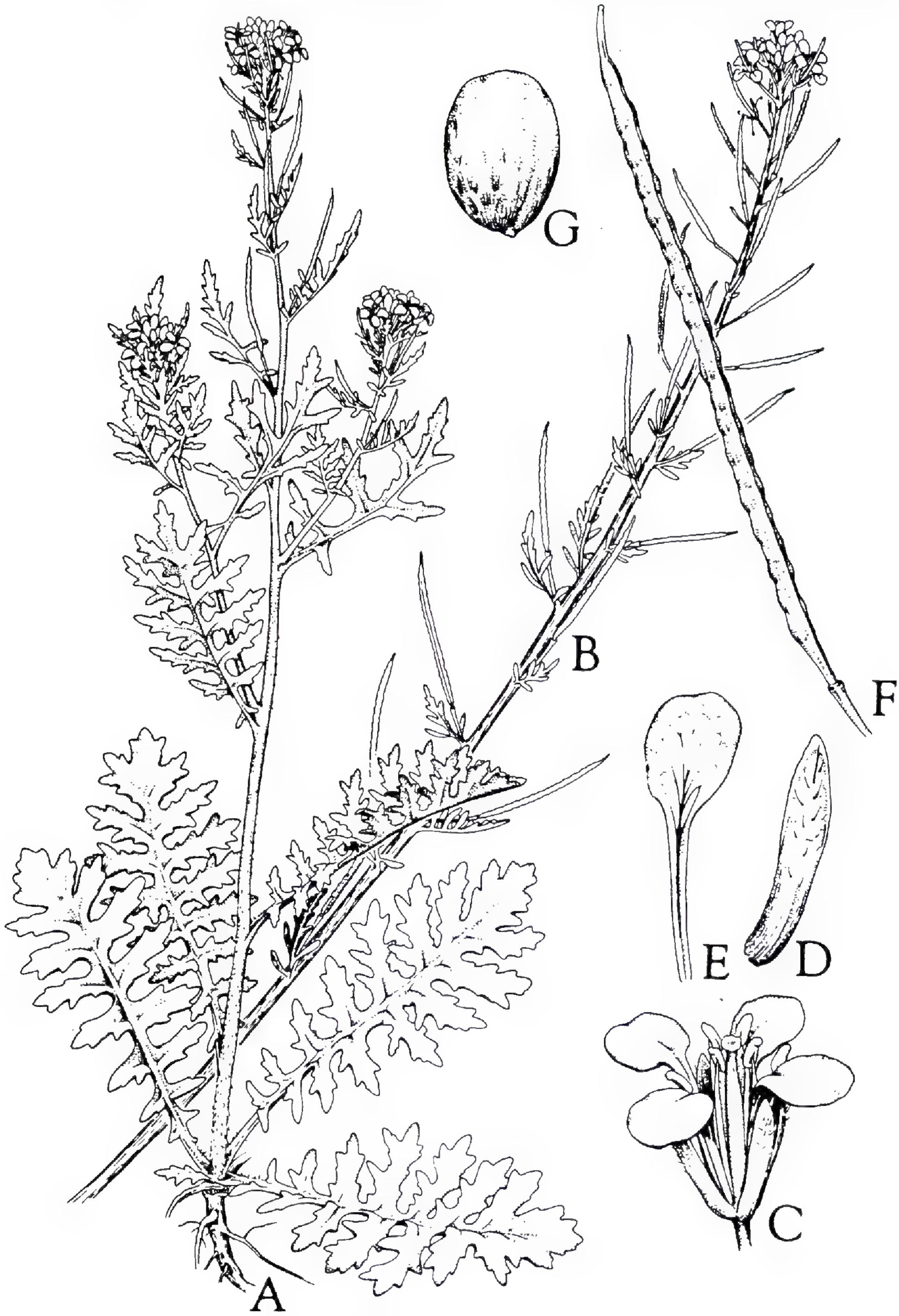


FIG. 1. *Erucastrum gallicum*, dog mustard. a. Habit, ×1/3. b. Flowering and fruiting raceme, ×1/3. c. Flower, × 5. d. Sepal, × 10. e. Petal, × 7.5. f. Fruit, × 2.5. g. Seed, × 12.5. Illustration from Mohlenbrock (1980).

decade of the 20th century: one each from North Dakota, Ohio, and Wyoming in 1909. During that decade, then, *E. gallicum* was present in four widely spaced localities in the United States.

During the second decade, collections of dog mustard were made in seven additional states: Massachusetts, Minnesota, Missouri, Montana, New York, Vermont, and West Virginia. The species was not reported from Canada until the third decade, when it was recorded first in Manitoba, followed soon by Ontario, Prince Edward Island, and Quebec (Groh 1933, 1934, 1941). Groh (1933) maintained that *E. gallicum* was probably present in Canada at earlier dates but was not officially recorded because of problems with identification. Similarly, it was probably also present in the United States prior to 1903.

With continuing spread from the 1930s to the present, the species has now been collected in at least 29 states of the United States from coast to coast and in all provinces and one territory of Canada. The many collections span, in latitude, 36 degrees from the Northwest Territories (ca. 61° N) south to Florida (ca. 25° N) and, in altitude, from sea level to at least 2000 m in the western mountains.

We list here the political areas in which dog mustard has been found and the date of the earliest specimen we have seen from each area. Following the dash after some of the dates are references to literature (excluding floras) that we have noted as being applicable to *E. gallicum* in those political areas.

UNITED STATES (1903–Robinson 1911): **Alabama** (1970), **California** (1929), **Connecticut** (1951), **Florida** (1977–Popenoe and Ward 1978), **Idaho** (1930), **Illinois** (1940–Steyermark and Swink 1949), **Indiana** (1930-Standley 1932), **Iowa** (1935), **Kansas** (1945), **Kentucky** (1938–Carr and Cohn 1941), **Maine** (1925–Bean et al. 1961; Kidder 1926), **Massachusetts** (1910–Bean et al. 1961; Blake 1928; Knowlton and Deane 1916; Robinson 1911), **Michigan** (1922–Farwell 1924), **Minnesota** (1910–Butters and Abbe 1953; Lakela 1939), **Missouri** (1912–Mühlenbach 1979), **Montana** (1919–Blake 1953), **New Hampshire** (1942–Bean et al. 1961), **New York** (1910–Muenscher and Maguire 1931), **North Dakota** (1909), **Ohio** (1909–Easterly 1964), **Oregon** (1975), **Pennsylvania** (1927–Wahl 1945; Wilkens 1940), **South Dakota** (1941), **Texas** (1926), **Vermont** (1911–Blake 1914), **Washington** (1923), **West Virginia** (1919–Blake 1924; Corbett 1973), **Wisconsin** (1903–Patman and Iltis 1961; Robinson 1911), Wyoming (1909).

CANADA (1922–Frankton and Mulligan 1987; Groh 1933): **Alberta** (1922–Groh 1937), **British Columbia** (1939–Groh 1941), **Manitoba** (1922–Batho 1939; Groh 1933, 1934), **New Brunswick** (1937–Groh 1939), **Newfoundland** (1948), **Northwest Territories** (1974–Cody 1978), **Nova Scotia** (1936–Groh 1933, 1934 [Groh cited a 1932 specimen but this was returned to the collector and is apparently no longer extant]), **Ontario** (1924–Groh 1933, 1934 [date of earliest Ontario collection mistakenly cited as 1925]; Montgomery 1957; Rousseau 1971b); **Prince Edward Island** (1926–Groh 1933, 1934), **Quebec** (1927–Groh 1933, 1934; Rousseau 1968, 1971b), **Saskatchewan** (1932–Groh 1933, 1934).

In summer 1992 one of us (JWT) searched for dog mustard in *many* likely sites in what we have come to call the *Erucastrum* belt of North America, i.e., Minnesota, the Dakotas, Alberta, Saskatchewan, and Manitoba. No plants of it were found, not even in a Minneapolis railroad yard where, in 1980, JWT had

seen numerous individuals of it. The only collection JWT made of the species during 1992 was far from the center of distribution of the species in North America: in downtown St. John's, Newfoundland.

Erucastrum gallicum may be extinct in many of the areas where it was originally collected. Myers and Henry (1979) noted that a number of alien plants in Illinois were not present 24-130 years after their initial collection in the state. These authors hypothesized that many "railroad or highway migrants did not persist" because modern pure seed laws reduced the chances for new introductions and spread.

MAPPING INVASION PATTERNS

Studies of changes in ranges of plant species rely primarily on specimens preserved in herbaria and secondarily (because of possible errors in identification) on literature records. Previous research suggests that plant collections are indeed reliable indicators of weed distribution (Forcella 1985). To document the invasion and spread of dog mustard in North America, we borrowed specimens from 70 U.S. and Canadian herbaria (see Acknowledgments). From each of the 1070 herbarium sheets we examined, we recorded the herbarium of deposit, collector, date of collection, habitat, and pertinent morphological data. No literature records were used although we include references to those we could locate.

We show on four maps (Figs. 2 and 3) of North America (between about the 60th parallel and the United States/Mexican border) the spread of *E. gallicum* in four time periods, the first three of these being 2 decades each, the fourth being 3+ decades: map 1 (Fig. 2A), 1900-1919; map 2 (Fig. 2B), 1920-1939; map 3 (Fig. 3A), 1940-1959; and map 4 (Fig. 3B), 1960-1992. The first map was produced by affixing a piece of graph paper (each square representing ca. 25,600 km^2) to a tracing box. Then our map of North America was positioned over the graph paper. Collection sites were located on the map and assigned to one of the underlying graph squares. If at least one collection fell within a particular graph square, a circle was placed centrally (relative to the graph square) on the map; one circle–and one only–was placed in each square, regardless of the number of localities that fell within that square. The remaining maps were produced in a similar way, the circles representing graph squares newly occupied for each time period, the dots representing graph squares occupied during the previous period(s). In a few instances, procrustean application of this method (*central* location of circles) resulted in a symbol being placed in a body of water (e.g., the circle in the Gulf of St. Lawrence near Prince Edward Island, representing a collection from that province) or in a state or province (or even a country) different from the actual locality of the collection being mapped. The circles and dots of the final map (Fig. 3B) represent the total North American range of *E. gallicum* as verified by us through 1992 from herbarium specimens.

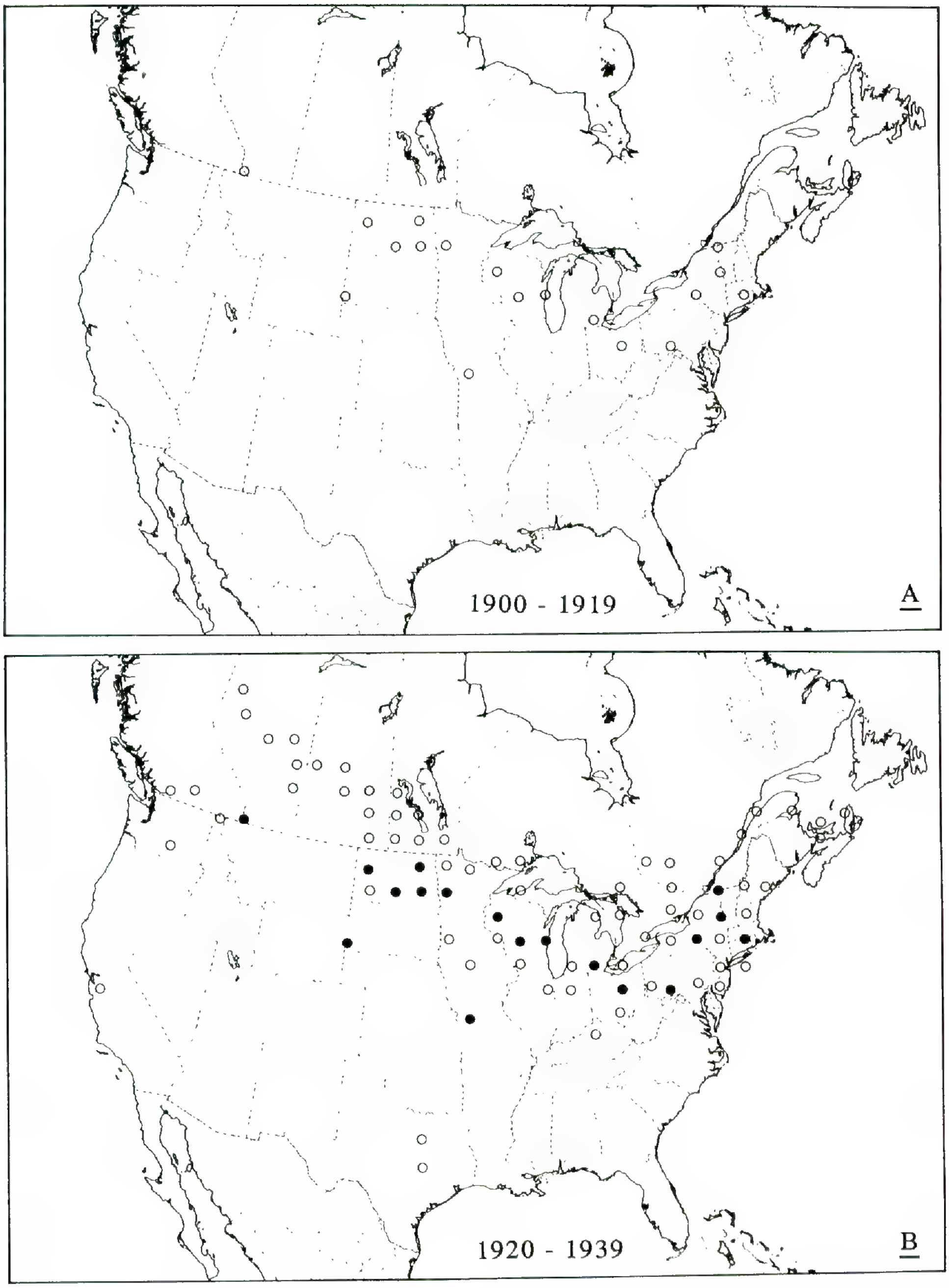
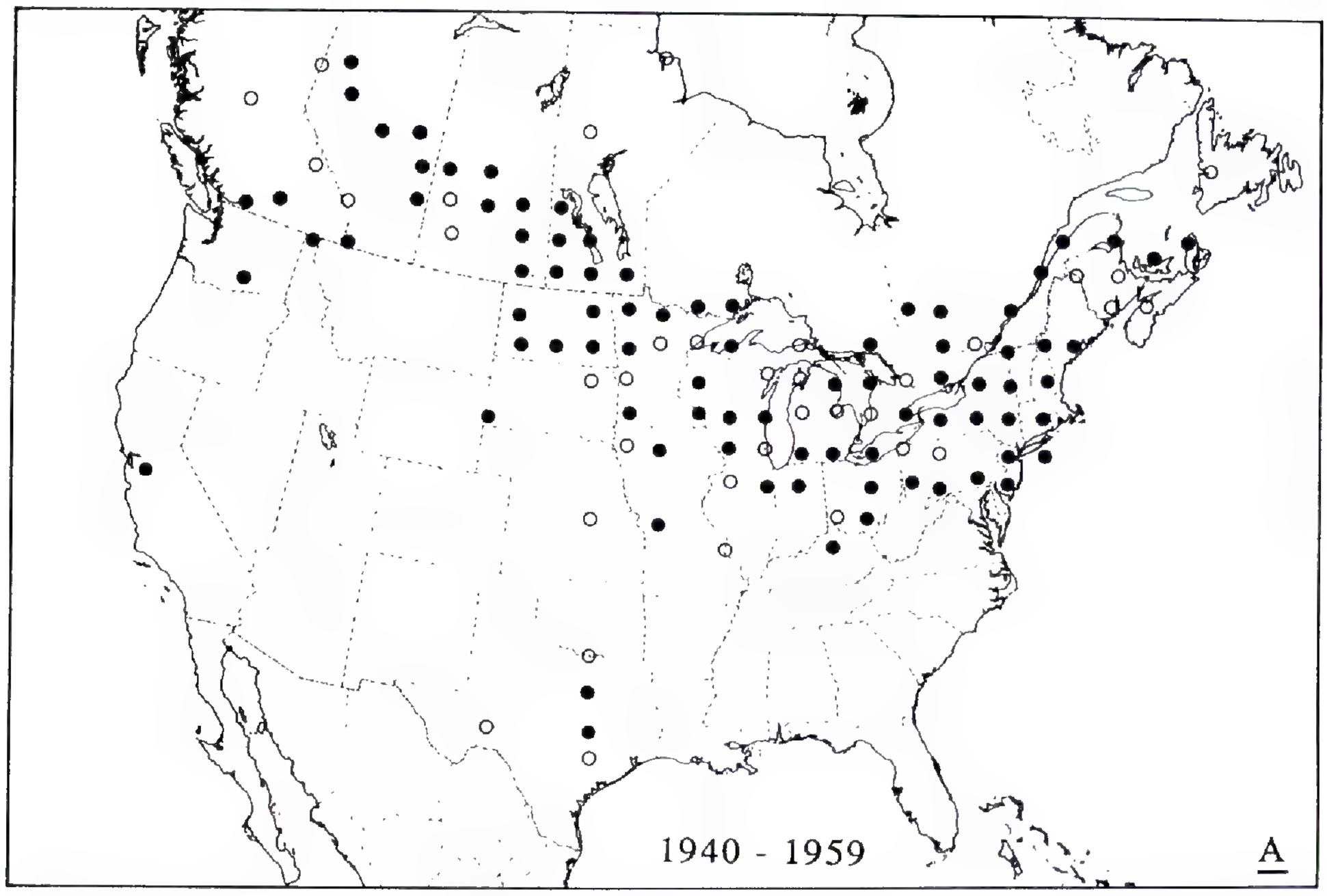


FIG. 2. Documented distribution of *Erucastrum gallicum* in North America, 1900–1939. Each circle represents the first occurrence of the species in a 25,600 km^2 area during the indicated time period; dots represent occurrences during previous time period(s). A. 1900–1919. B. 1920–1939.



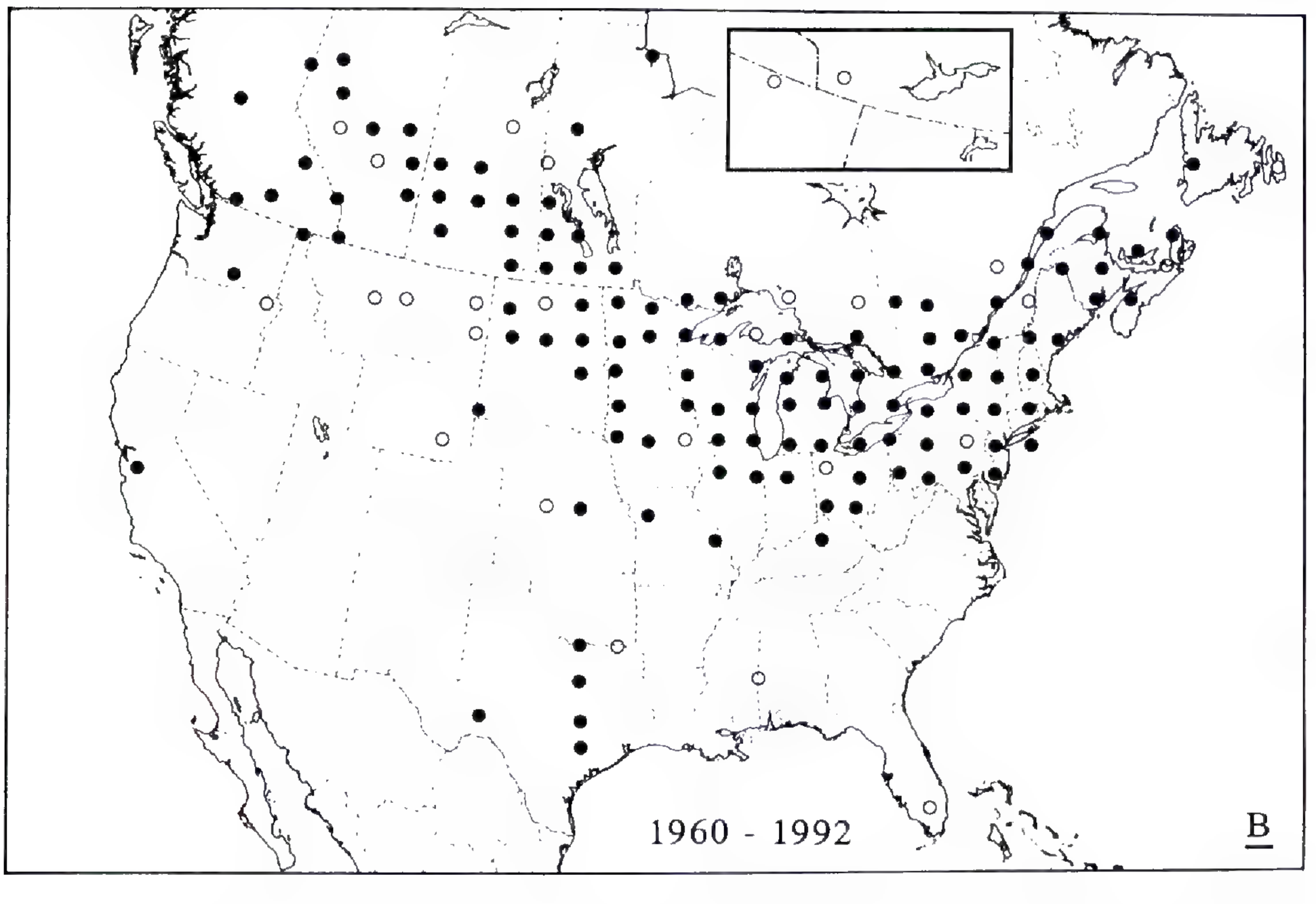


FIG. 3 Documented distribution of *Erucastrum gallicum* in North America, 1940–1992. Each circle represents the first occurrence of the species in a 25,600 km^2 area during the indicated time period; dots represent occurrences during previous time period(s). A. 1940–1959. B. 1960–1992. Inset shows northern British Columbia, northern Alberta, southwestern Mackenzie, and southeastern Yukon.

OBSERVATIONS ON HABITAT

In the sesquipedalian terminology so beloved by ecologists, dog mustard seems best described as an "epoecophyte" (Rousseau 1971b), defined by Rousseau (1971a) as a species established "seulement dans les endroits rudéraux et/ou les champs cultivés." Its most common habitat is railroads followed by roadsides, waste ground, and then various other open, sparsely vegetated sites (Fig. 4). Sometimes *E. gallicum* occurs as a weed in cultivated fields (Alex 1966; Groh 1933), but clearly this is not the most common habitat. After the crop is harvested, dog mustard plants may sometimes "fill a field with bloom in September" (Batho 1939).

The types of habitats where dog mustard most commonly occurs and long-term demographic data (Klemow and Raynal 1983) suggest that the plants do not require disturbance for establishment. Rather, they become established in denuded sites that are sparsely vegetated as a result of past disturbance, low fertility, and harsh microclimate. In the absence of repeated disturbance, *E. gallicum* may persist if competing vegetation is suppressed (Klemow and Raynal 1983), or it may be eliminated through competitive interactions (Milberg 1991). The most recent collections we examined did not suggest that *E. gallicum* is currently a major weed.

INVASION PATTERNS

Baker (1974) identified two patterns of spread by invaders. These are best described as "echelon" movement and "spot and fill" movement. In "echelon" movement, plants have a single point of introduction followed by movement across the landscape in wave- or step-like progression, e.g., *Filago arvensis* (Forcella and Harvey 1982). In "spot and fill" movement, several centers of introduction may be followed by a filling of the intervening open spaces. Clearly, *E. gallicum* is characterized by the "spot and fill" pattern. According to Baker (1974), the latter is the most common pattern of weed invasion in North America.

Some evidence suggests that regional movement of *E. gallicum* is associated with the transportation system. Most notable is the band of *E. gallicum* that penetrates Canada via a route through Manitoba, Saskatchewan, and Alberta and the line of *E. gallicum* through Texas. Both routes parallel railroads.

Railroads contribute suitable habitat and possibly a mechanism for dispersal. As noted by Mühlenbach (1979), frequent spraying with herbicides in railroad yards creates extensive open habitat that is colonized by a host of invasive species. Furthermore, the attachment of seeds to the surface of trains or the presence of seeds in the cargo of trains may facilitate long-distance dispersal. Seeds may also be spread through importation of forage (as on St. Pierre; Roger Etcheberry, pers. comm.) or grain (as in Britain; Carruthers 1865) for stock.

All of the first collections of *E. gallicum* in the United States presented on map

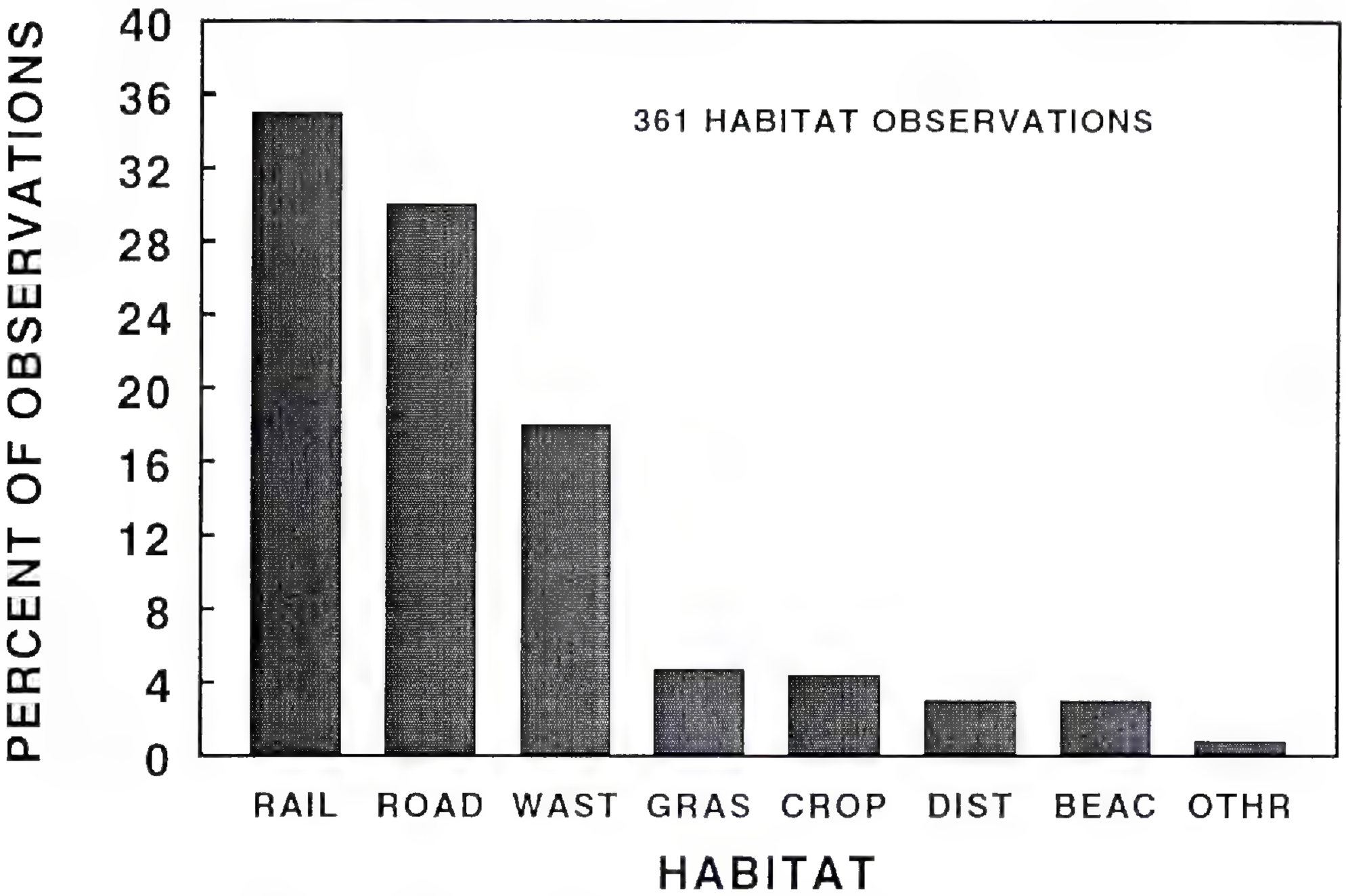


FIG. 4. Percentage distribution of habitats where *Erucastrum gallicum* has been collected, 1900-92. RAIL = railroad; ROAD = roadside; WAST = waste ground; GRAS = grassland; CROP = cropland; DIST = disturbed ground; BEAC = beach; OTHR = other habitats.

1 (Fig. 2A) were made along railroads; thus we assume that railroads facilitated the initial spread here. In Canada a similar trend is noted, with the exception that initial collections span a greater range of habitats and that cultivated fields are better represented. This suggests possible introduction through contamination of crop seed. Further evidence suggesting movement of *E. gallicum* in grain shipments is provided by collections near grain elevators and at grain shipping terminals, e.g., at Churchill, Manitoba.

Erucastrum gallicum may have reached its maximum rate of spread soon after invasion into North America; it may also be close to expressing its final distribution. From its initial establishment during 1900-1919, it reached its greatest rate of spread during 1920-1939 (3.4 graph squares/year). The rate was then slower during 1940-1959 (1.8 graph squares/year) and slower yet during 1960-1992 (0.8 graph squares/year). The lack of explosive invasion across large areas of North America indicates that *E. gallicum* is not likely to become a major problem weed (Forcella 1985).

ADDITIONAL NOTES ON DISTRIBUTION

Dog mustard was first collected on Saint-Pierre et Miquelon in 1982 near the Animal Quarantine in the town of St. Pierre (Roger Etcheberry, pers. comm.), possibly introduced via the forage imported from 1964 to 1976 for quarantined

animals (cattle to be sent to Canada). The voucher specimen (Abraham 347) sent to NFLD is apparently lost.

A California specimen of *E. gallicum* (Van LöbenSels [?] *s.n.*, CAS) collected on the campus of Stanford University in 1929 was the basis for the report by Abrams (1944) that dog mustard was "locally introduced in Santa Clara County, California." The species was *not* included in the California flora by Munz and Keck (1959) or in the account of alien plants of California by Robbins (1940), but it *does* appear in the revision of the Jepson California manual (Hickman 1993) on the basis of the Stanford collection (Susan M. Dalcamo, pers. comm.).

The Louisiana report of dog mustard (MacRoberts 1979, 1989) was based on misidentification of a species of *Brassica*.

TAXONOMY

Erucastrum is a genus of about 20 species endemic to western Eurasia (east to the Arabian Peninsula), Macaronesia, and much of Africa (Al-Shehbaz 1985; Rytz 1936). The genus has been considered to be a section of *Brassica* or of *Hirschfeldia*, but recent authors have maintained it as distinct and closely related to *Brassica* (Al-Shehbaz 1985).

The following description of *E. gallicum* is based on our study of ca. 1000 specimens, all of them from North America.

Erucastrum gallicum (Willd.) O.E. Schulz

Sisymbrium gallicum Willd.
Diplotaxis bracteata Godr.
Erucastrum pollichii Schimp. & Spenn.
Hirschfeldia gallica (Willd.) Farwell

More extensive synonymy, mostly not applicable to North American literature, is given by Al-Shehbaz (1985) and by Schinz & Thellung (1921).

Annual (rarely winter annual or biennial), with taproot. Stem erect or ascending, unbranched or branched from the lower nodes, 0.9–6.5(8) dm tall, sparsely to densely pubescent with mostly retrorse, simple trichomes, especially below. Basal and lower leaves oblanceolate, 3–28 cm long and 0.8–11 cm wide, sometimes anthocyanous-tinged (especially below), sparsely pubescent, merely acute- or obtuse-toothed to usually deeply lobed, proximal lobes the smallest, terminal lobe often the largest, lobes mostly 3–10 on each side, 0.2–4.5 cm long, crenately or angularly dentate to lobed; cauline leaves similar, progressively reduced, the uppermost 1–2 cm long, passing gradually into floral bracts, the uppermost bracts usually progressively less deeply lobed, becoming as short as 2 mm long and 0.3 mm wide, entire, linear. Inflorescences terminal, conspicuously elongating in fruit, the proximal pedicels bracteate at base. Flowers in racemes; pedicels 2–16 mm long; sepals 2.5–4.5 mm long, erect to spreading, somewhat cucullate at tip; petals pale yellow or whitish, spatulate, 4–8 mm long; nectar

glands 4 (one subtending each of the two pairs of long stamens, one between the ovary and each of the two short stamens [Clemente Muñoz and Hernández 1978]); ovary cylindric, stigma capitate; ovules numerous. Siliques usually upcurved, ± linear, often somewhat torulose, body 1–4.5 cm long, 1–2(2.7) mm wide, 4-angled, beak 1.5–4 mm long, without seeds, septum 0.9–1.5 mm wide, valves 1-veined; seeds in 1 row in each locule, 1.1–1.5 mm long, 0.7–0.8 mm wide, reddish orange, alveolate (Murley 1951), cotyledons conduplicate. (n = 15 [Harberd 1972]; $2n$ = 30 [Manton 1932; Mulligan 1957]). Flowering March through December (depending on locality), maturing fruit soon thereafter.

ETYMOLOGY

The common name "dog mustard" is a more or less literal translation of a German common name for this species, *Hundsrauke*, in which *rauke* refers to *Eruca sativa* Mill. (rocket-salad, garden rocket, rocket, roquette) and *Hunds* implies false or spurious (Marzell 1951)–all suggesting a resemblance to *Eruca sativa*. The generic name, *Erucastrum*, means much the same, false eruca, deriving from *Eruca* + the suffix *astrum*, indicating similarity. The specific epithet, *gallicum*, derives from the commonness of the species in western Europe (Marzell 1951).

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VALIDATION OF SEVERAL BRAZILIAN *MIKANIA* (COMPOSITAE: TRIBE EUPATORIEAE) NAMES

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ABSTRACT

Mikania hoffmanniana var. ***macrophylla***, ***M. pseudohoffmanniana***, ***M. pseudohoffmanniana*** var. ***microphylla***, and ***M. barrosoana*** are validated as new species.

RESUMEN

Se validan como nuevas especies ***Mikania hoffmanniana*** var. ***macrophylla***, ***M. pseudohoffmanniana***, ***M. pseudohoffmanniana*** var. ***microphylla***, y ***M. barrosoana***.

KEY WORDS: Compositae, Eupatorieae, *Mikania*, Brazil.

In studying the *Mikania* species of Paraná, Brazil, it was determined that several of the species and varieties proposed by Barroso (1958) were not validly published because of failure to indicate the nomenclatural type as required by Article 37 of the International Code of Botanical Nomenclature. Article 37 states that "publication on or after 1 Jan. 1958 of the name of a new taxon of the rank of family or below is valid only when the nomenclatural type is indicated." In such cases where types have not been designated, valid publication can be effected by reference to the original protologue and designation of a type specimen for each of the proposed names. While I am not obligated to retain the names as proposed by Barroso (1958), I elect to do so in an effort to promote a sense of nomenclatural stability. It should be noted that although dated as 1958, Barroso's treatment of the *Mikania* of Brazil was not released until 1959.

Mikania hoffmanniana Dusén ex Malme var. **macrophylla** G. M. Barroso ex W. Holmes, var. nov. BASIONYM: *Mikania hoffmanniana* Dusén ex Malme var. *macrophylla* G. M. Barroso, nom. illeg., Arq. Jardin. Bot. Rio de Janeiro 15:284. 1958 [1959]. TYPE: BRAZIL. Rio de Janeiro, Serra dos Órgãos, Pedra do Roncador, 1600 m, 11 Jul 1940, *Brade 16701* (HOLOTYPE: RB).

Mikania pseudohoffmanniana G. M. Barroso ex W. Holmes, sp. nov. BASIONYM: *Mikania pseudohoffmanniana* G. M. Barroso, nom. illeg., Arq. Jardin Bot. Rio de Janeiro 15:285–286. 1958 [1959]. TYPE: BRAZIL. PARANÁ, Carvalho, 12 Sep 1911, *Dusén 12189* (HOLOTYPE: S).

Synonyms include *Mikania hoffmanniana* Dusén ex Malme var. *polycephala* Dusén ex Malme and *Mikania polycephala* Dusén ex Malme, nom. nud. in syn., both published in Svensk. Vet. Akad. Handl. Ser. 3. 9(2): 54. 1933. While the

varietal name has date priority, the name *Mikania polycephala* was previously and validly published by Urban in Symb. Antill. 2: 459. 1901 as the name of a species from Hispaniola.

Mikania pseudohoffmanniana G. M. Barroso ex W. Holmes var. **microphylla** G.M. Barroso ex W. Holmes, var. nov. BASIONYM: *Mikania pseudohoffmanniana* G. M. Barroso var. *microphylla* G. M. Barroso, nom. illeg., Arq. Jardin Bot. Rio de Janeiro 15: 286. 1958 [1959]. TYPE: BRAZIL. PARANÁ, Estrada da Graciosa, Alta da Serra, 22 Apr 1951, *Gert Hatschbach 2244* (HOLOTYPE: MBM).

Mikania barrosoana G. M. Barroso ex W. Holmes, sp. nov. BASIONYM: *Mikania barrosoana* G. M. Barroso, nom. illeg., Arq. Jardin Bot. Rio de Janeiro 15:296–297. 1958 [1959]. TYPE: BRAZIL. Rio de Janeiro, Cantagalo a Laranjeiras, 5 Jul 19881, *Glaziou 12872* (HOLOTYPE: R).

In additional to the above, a type specimen is not designated for *Mikania rotundifolia* Barroso, Arq. Jardin Bot. Rio de Janeiro 15: 251. 1958 [1959]. That name, however, is considered to be a synonym of *M. salzmanniaefolia* DC., thus need not be validated.

ACKNOWLEDGMENTS

I am grateful to John H. Wiersema of BARC and Sidney McDaniel of IBE for their advice on application of the International Code of Botanical Nomenclature.

REFERENCE

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A NEW SPECIES OF *MIRABILIS* (NYCTAGINACEAE) FROM JALISCO, MEXICO

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ABSTRACT

A new species, *Mirabilis russellii*, belonging to the section *Oxybaphoides*, is described and illustrated. It is known from two collection sites along the coast of Jalisco. It is rather common along the entry road to the Instituto de Biologia de la Universidad Nacional Autonoma de Mexico, Chamela, Mexico, in tropical deciduous vegetation.

RESUMEN

Se describe e ilustra una especie nueva, *Mirabilis russellii*, perteneciente a la sección *Oxybaphoides*. Se conoce únicamente de dos colectas a lo largo de costa de Jalisco. Es común en el camino de entrada a la estación biología de la Universidad Nacional Autónoma de Mexico "Chamela," México, en bosques bajos caducifolios.

Mirabilis russellii Le Duc, sp. nov. (Fig. 1).

Mirabili oliganthae (Standl.) Macbride arcte affinis sed anthocarpiis pubescentibus clavatis 5-porcatisque differt.

Much branched shrubby perennial, 4–7 dm high, branches glandularly pubescent to glabrous, the nodes only slightly swollen. Mid-stem leaves 3–5 cm long, 2.5–3.5 cm wide, petioles slender 1–2 cm long; blades puberulent, broadly to narrowly ovate, cordate or slightly truncate at the base, the apex acuminate, the margin entire, sparsely ciliolate. Involucres solitary or in cymules, in the axiles of upper leaves or sometimes terminal; pedicels 2–5 mm long, pubescent. Involucre one-flowered, slightly accrescent in age, narrowly campanulate, 7–10 mm long, glabrous or slightly glandular pubescent, the lobes narrowly triangular, as long or longer than the tube, margin ciliolate. Perianth 1.5–2.5 cm long, pink, expanded upwards, limb 8–15 mm broad, the lobes obtuse. Stamens 5, exserted ca. 4–8 mm beyond perianth. Pollen grains 0.11–0.12 mm in diameter. Anthocarp light brown, oblong-clavate, 7–9 mm long, ca. 3 mm wide, 5-angled, the ridges tuberculate, scattered puberulent, constricted at both base and apex, mucilaginous when wet.

TYPE: MEXICO. JALISCO: on the banks along the entrance road to the UNAM Biological Research Station, Chamela, in tropical deciduous forest; vegetative specimen, material transplanted and

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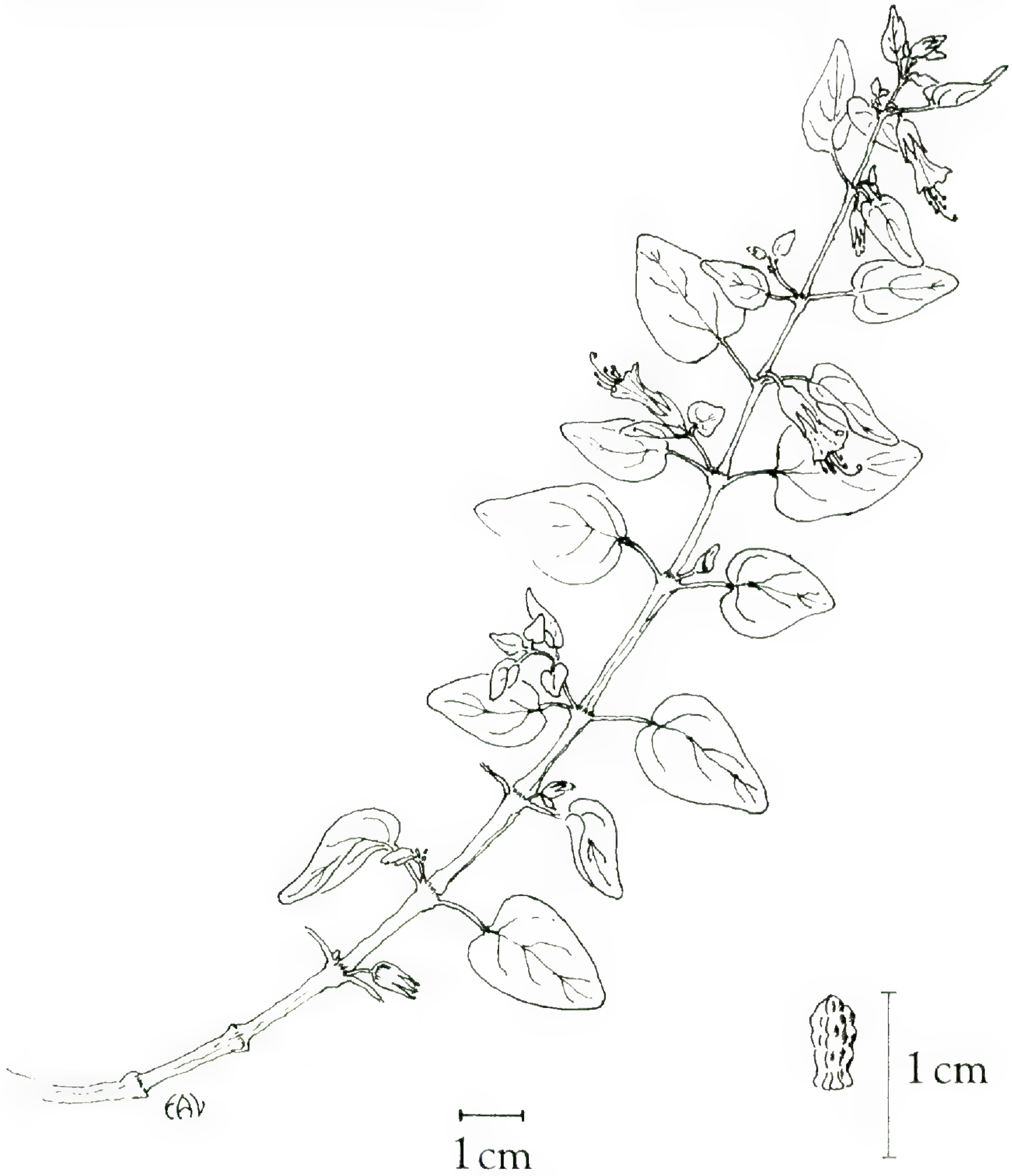

FIG. 1. *Mirabilis russellii* from the holotype. Showing: flowering stem and enlarged detail of the anthocarp.

grown in greenhouse, with subsequent flowers attached, 10 Aug 1992, *Le Duc 250* (HOLOTYPE: TEX!; ISOTYPES: UNAM, to be distributed).

Additional specimens examined: MEXICO. JALISCO: Manzanillo - Puerto Vallarta Road, Tomatlan, 15 Feb 1975, *R. McVaugh 26317* (MICH); Mpio. La Huerta, Estacion de Biologia Chamela (UNAM). Camino Entrada, cera la Estacion, 25 Nov 1981, *E.J. Lott 574* (NMU).

Distribution. Known from the coastal tropical deciduous forest of Jalisco, Mexico.

Phenology. Flowering from November to March (or longer in the greenhouse). Blooms open in the morning only.

Monographic studies of *Mirabilis* section *Mirabilis* have revealed a heretofore undescribed species, *Mirabilis russellii*. Its placement lies in section *Oxybaphoides* because of its shrubby habit, involucres single-flowered and only slightly accrescent in age, perianth campanulate, and anthocarps mucilaginous when wet. Within section *Oxybaphoides* this new species appears to be related to the *Mirabilis tenuiloba* S. Wats. - *M. oligantha* (Standl.) Macb. group because of the lanceolate involucral lobes which are at least as long as or longer than the tube. However, the clavate, five ridges, and the pubescence of the anthocarp set *M. russellii* apart from the other taxa of section *Oxybaphoides*. These same anthocarp characters are similar to those exhibited by several taxa of the section *Oxybaphus* (i.e., *M. hirsuta* (Pursh.) MacM., *M. pumila* (Standl.) Standley, *M. decumbens* (Nutt.) Daniels, *M. oblongifolia* (A. Gray) Heimerl. *Mirabilis russellii* is not placed in section *Oxybaphus*, however, because the involucral and perianth morphology of this new species firmly establishes its close relationship with taxa of section *Oxybaphoides*.

This species is named in honor of my son Russell Jack who has been so supportive of my graduate studies.

ACKNOWLEDGMENTS

I am grateful to Luis Hernandez for the Spanish resumen and to Guy Nesom for the Latin diagnosis. The illustration is provided by the author.

BOOK NOTICES

BERNHARDT, PETER. 1993. **Natural Affairs.** (ISBN 0-679-41316-2, hbk). Villard Books, New York. $25.00. 226 pp.

Subtitled "A Botanist Looks at the Attachments between Plants and People," this volume is a potpourri of essays on disparate botanical topics. The 14 chapters cover greenhouses/Rousseau/Mapplethorpe, a plant sanctuary near Melbourne, the botany of salads, the saffron crocus, passion flowers, heterostyly, nectar and nectaries, hoons and *Cannabis*, wattles (*Acacia*), *Lycaste* orchids, magnolias, columbines, daffodils, and orchids in cemeteries. Then follow an annotated bibliography (45 entries) and an index. Illustrations are line drawings and a few plates of splendid color photos. Bernhardt's chatty style combines with the interesting subject matter to make this book good and recommended reading.—*John W. Thieret.*

JOHNSTON, STANLEY H., JR. (compiler). 1992. **The Cleveland Herbal, Botanical, and Horticultural Collections.** (ISBN 0-87338-433-4, hbk). Kent State University Press, Kent, OH. $85.00. 1012 pp.

This is an account of the pre-1803 works in Cleveland's Holden Arboretum, the Cleveland Medical Library Association, and the Garden Center of Greater Cleveland. Detailed bibliographic data are given for 977 books plus a few manuscripts and paintings; the earliest entries are "c. 1477" and a definite 1479. The "Notes" give data on authors and their works, a bonus for the general reader. Even to those who have no special knowledge of old botanical literature, quite a few of the authors' names will be familiar as the basis of many well-known generic names, e.g., *Commelina, Lindernia, Linnaea, Lobelia, Lonicera, Monarda, Ruellia*, and many others. Separate indexes are given to authors/titles, printers/publishers, illustrators, portraits, and non-botanical illustrations. The bibliography has about 160 entries. Persons interested in early literature on plants will want this book, as will botanical and biological libraries, for which it is a "must" reference work and a reminder of our rich botanical heritage.—*John W. Thieret.*

MCALISTER, WAYNE H. and MARTHA K. MCALISTER. 1993. **Matagorda Island. A Naturalist's Guide.** (ISBN 0-292-75150-8, hbk). University of Texas Press, Austin, TX 78713-7819. $19.95 (pbk); $40.00 (hbk). 354 pp.

Lying just northeast of Corpus Christi, Matagorda Island is one of the Texas barrier islands, less well known and less easily accessible than Padre Island a few miles to the south. This book is an fine guide to this bit of real estate (38 miles long and up to about 5 miles wide). The 10 chapters cover generalities (e.g., location, physiography, soils, climate, precipitation, temperature, storms, the human factor, Matagorda Island State Park and Wildlife Management area, how to get there [by ferry only], and tips for visitors), geology, history, ecology, vegetation, mammals, birds, herptiles, fishes, and invertebrates. Following are five appendices (mainly lists of island organisms), a three-page bibliography, and an index. One of the best "naturalists' guides" that I have seen, this well-written and most interesting book is recommended as good reading even for those who may never visit its subject island.—*John W. Thieret.*

TYPIFICATION OF TWO BUCKLEY GRASS NAMES REVISITED: *MUHLENBERGIA TEXANA* AND *M. MONTICOLA* (POACEAE)

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INTRODUCTION

Samuel B. Buckley (1862) based new species of grass on collections he made in Texas and also specimens that had been deposited in the herbaria of the Academy of Natural Sciences of Philadelphia (PH) and Elias Durand (now P-DU). Asa Gray (1862; see also Buckley 1870) took exception to Buckley's work on grasses and wrote a scathing review, which clarified details pertinent to the typification of these names. In his review, Gray (1862) noted that he had borrowed the specimens that Buckley had used in preparing his paper and that he showed them to the agrostologist George Thurber. Details concerning Buckley's work habits and the specimens that he examined are complicated. Consequently, mistakes frequently are made in selecting lectotypes for Buckley names. Comments on the lectotypifications of two Buckley grass names are given below.

Muhlenbergia texana Buckley

In a recent revision of the annual species of *Muhlenbergia* Schreber (Poaceae), Peterson & Annable (1991) designated *Wright 739* (US) as the lectotype of *Muhlenbergia texana* Buckley and they considered a duplicate at MO to be an isolectotype. Their choice, however, must be superseded. Fortunately, changing the lectotype does not change the application of this name.

First, there is no evidence that Buckley used *Wright 739* material in describing this species. Gray's (1862) comments indicated that this name was based on material in the Academy (PH), which presumably was collected by Buckley: "*Muhlenbergia Texana.* No specimens were communicated under this name, but one given by Mr. Buckley to the Academy's herbarium under the name of '*Agrostis barbatis,* Buckl.' may, from the description, be the plant intended. This is a form of *Sporobolus ramulosus.*"

Secondly, Buckley did not have access to the Wright specimens that are now in the U.S. National Herbarium (US). The Wright material that Buckley used to describe other species of grass was in the herbarium of the Academy (PH) and possibly that of Durand (now P-DU).

Finally, Peterson & Annable (1991) mistakenly wrote *Wright 739* for *Wright*

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736. Wright 739 at GH and NY is *Aristida wrightii* Nash (the type is *Reverchon 1061*, not a Wright collection). *Wright 736* at GH, NY, and US is *Muhlenbergia texana* Buckley.

There is original material of *Muhlenbergia texana* Buckley in the Academy (PH) that can serve as the lectotype of this name. It is part of a sheet with four specimens, one of which is labeled "*Agrostis barbatis*/ Buckl." by Buckley. Gray's (1862) published comments were attached to Buckley's specimen and it was annotated by Thurber: "*Sporobolus ramulosus* Rth./ This I think is/ *Muhlenbergia Texana* Buckl./ G[eorge] T[hurber]." We here select the material labelled *Agrostis barbatis* by Buckley at PH as lectotype. We have seen no duplicates of this collection.

Muhlenbergia monticola Buckley

Buckley (1862) cited no collector and gave scanty locality data ("Northwestern Texas") when he described *Muhlenbergia monticola* Buckley.

It was Gray (1862) who indicated that this name was based on *Wright 731* & *733*. Clearly these Wright collections at PH (or P-DU) are syntypes and only one of them can serve as the lectotype. Annotations on the material at PH (both *Wright 731* & *733* are mounted on the same sheet) indicate that A. S. Hitchcock thought Buckley's species was based on two different elements. He annotated *Wright 731* as *M. monticola* and *Wright 733* as *M. parviglumis* Vasey. Subsequently, Hitchcock (1950), in presenting a synonymy of *M. monticola*, listed *Wright 731*, but he did not designate it the type of this name. Peterson & Annable (1991) considered *Wright 731* at US to be the holotype and *Wright 731* at MO an isotype thereby effectively lectotypifying the name. Buckley, however, did not examine either specimen. He studied *Wright 731* at the Academy (PH) or in Durand's herbarium (now P-DU). We here select the material at PH as lectotype. Consequently, duplicates of *Wright 731* at US and MO become isolectotypes. However, *M. monticola* is a synonym of *M. tenuifolia* because of earlier publication.

Shaw (1987) indicated that *Wright 731* was made up of a single field number (*972*) of a grass that Wright collected on hills in the "Pass of the Limpia" on August 24, 1849. There is reasonable certainty that duplicates of *Wright 731* are part of a single gathering. McVaugh (1948) determined the Pass of the Limpia to be the same as Wild Rose Pass, northeast of Fort Davis, Jeff Davis Co., Texas.

TAXONOMIC SUMMARY

Muhlenbergia texana Buckley, Proc. Acad. Nat. Sci. Philadelphia 14: 91. 1862.

Podosemum texanum (Buckley) Bush, Amer. Midl. Naturalist 7: 41. 1921. TYPE. [U.S.A.] Northern Texas ["*Agrostis barbatis* Buckl."], May, [leg. *S. B. Buckley?*] (LECTOTYPE, here designated: PH!).

= *Agrostis barbatis* Buckley ex Gray, Proc. Acad. Nat. Sci. Philadelphia 14: 334. 1862, nom. nud., pro syn.

= *Muhlenbergia buckleyana* Scribner in Coulter, Contr. U. S. Natl. Herb. 1(2): 56. 1890, nom. superfl.

Muhlenbergia tenuifolia (H.B.K.) Kunth, Révis. Gramin. 1(4): 63. 1829.

– *Muhlenbergia monticola* Buckley, Proc. Acad. Nat. Sci. Philadelphia 14: 91. 1862; Gray, Proc. Acad. Nat. Sci. Philadelphia 14: 334. 1862. TYPE. [U.S.A. Texas. "Side of hills in the Pass of the Limpia," 24 Aug 1849], *Charles Wright 731* (LECTOTYPE, here selected: PH!; ISOLECTOTYPES: MO!, US!).

See Peterson and Annable (1991) for other synonyms.

ACKNOWLEDGMENTS

The curators of GH, MO, NY, PH, and US kindly lent or allowed us to examine specimens in their care.

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BOOK NOTICES

NATIONAL RESEARCH COUNCIL. 1992. **Neem. A Tree for Solving Global Problems.** (ISBN 0-309-04686-6, pbk). National Academy Press, Washington, DC. No price given. 141 pp.

An Asiatic member of the mahogany family, neem (*Azadirachta indica) is* a current wonder plant being touted for an impressive variety of uses: reforestation, pharmaceuticals (the tree has been called "the village pharmacy"), biocides (against phytophagous insects, nematodes, snails, an ostracod, certain fungi, and some viruses, but non-toxic to humans), source of a fixed oil, fertilizers, timber, fuel, twigs for toothbrushes, and contraceptives—especially as a spermicide. This book summarizes data on the tree and discusses the need for and approach to further investigation of neem. Worldwide research contacts and about 110 references are listed. This is another excellent report from the U.S. Board on Science and Technology for International Development.—*John W. Thieret.*

DAVIS, LINDA W. 1993. **Weed Seeds of the Great Plains.** (ISBN 0-7006-0651-3, hbk). University Press of Kansas, Lawrence, KS. $25.00 (plus $3.00 shipping and handling). 145 pp.

The particular glory of this book is the 280 superb color photos of various seeds grouped, six per page, into 48 full-page plates. Additionally, the work gives detailed descriptions of these seeds, each description accompanied by a life-size silhouette photo of its subject. "Finding lists," essentially an unconventional key, help in identification. Included, too, are a list of some other books useful in seed identification; a glossary, with many terms illustrated; and an index to common and scientific names.—*John W. Thieret.*

GUNTER, PETE A.Y. 1993. **The Big Thicket. An Ecological Reevaluation.** (ISBN 0-929398-52-1, pbk). University of North Texas Press, Denton, TX. $14.95. 229 pp.

In far southeastern Texas is the Big Thicket, that wild and fascinating region written about in this book. Pete Gunter tells of the history and biological diversity of the area, much of which has now been spared further destruction: the Big Thicket National Preserve was created in 1974, "a testimony to the persistence and vision of many people." (Too late, though, for the presumably now-extinct ivory-billed woodpecker, probably the most heralded member of the region's fauna.) About one-quarter of the book is "A user's guide," which should be read by anyone planning a visit to the preserve. An appendix lists "Representative flora and fauna of the Big Thicket," a bibliography and an index close the book.—*John W. Thieret.*

ADDITIONAL TRANSFERS OF CHINESE *ACANTHOPANAX* TO *ELEUTHEROCOCCUS* (ARALIACEAE)

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ABSTRACT

The priority of *Eleutherococcus* Maxim. over *Acanthopanax* (Decne. & Planch.) Witte necessitates additional transfers of *Acanthopanax baoxinensis* X.P. Fang et C.K. Hsieh, *A. cissifolius* (Griff. ex Seem.) Harms var. *glaber* Y.R. Li, *A. nanpingensis* X.O. Fang et C.K. Hsieh, *A. giraldii* Harms var. *pilosulus* Rehd. and *A. yui* H.L. Li var. *villosus* Y.R. Li to the genus *Eleutherococcus*.

RESUMEN

La prioridad de *Eleutherococcus* Maxim. sobre *Acanthopanax* (Decne. & Planch.) Witte necesita las transferencias adicionales al género *Eleutherococcus* de *Acanthopanax baoxinensis* X.P. Fang et C.K. Hsieh, *A. cissifolius* (Griff. ex Seem.) Harms var. *glaber* Y.R. Li, *A nanpingensis* X.P., Fang et C.K. Hsieh, *A. giraldii* Harms var *pilosulus* Rehd. y *A. yui* H.L. Li var *villosus* Y.R. Li.

KEY WORDS: *Eleutherococcus*, *Acanthopanax*, Araliaceae, new combinations

Acanthopanax was first used as a subgeneric name of *Panax* L. by Decaisne and Planchon (1854). It was later raised by Witte (1861, cf. Philipson 1979) and Miquel (1863) to generic rank. *Acanthopanax* (Decne. & Planch.) Witte and *Eleutherococcus* Maximowicz (1859) were recognized by Bentham & Hooker (1865), Forbes & Hemsley (1888), Nakai (1914), 1924, 1927), Poyarkova (1950), etc. as separate genera. However, Harms (1894, 1918) combined both genera and recognized *Eleutherococcus* in sectional rank under the genus *Acanthopanax*, a treatment that cannot be allowed under the current ICBN. Harms' treatment was followed by Rehder (1940, 1949), Li (1942), and many other floristic botanists in China, Japan and southeastern Asia (e.g. Philipson 1979). However, Stone (1980) transferred to *Eleutherococcus* from *Acanthopanax* the single Malayan

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species, *A. malayanus* Henderson, and affirmed the nomenclatural need for further changes of this kind to consolidate the name which has priority.

The late Hoo & Tseng (1978) accepted Harms' system (1918) (except sect. *Kalopanax* which was regarded as a distinct genus). They used *Acanthopanax* as the generic name, and noted that that name had been in common use for long periods and should be conserved over the earlier synonym *Eleutherococcus*. But they did not put forward such a proposal. Nearly all the floristic works as well as publications of pharmaceutical botany in China have followed Hoo & Tseng's treatment. However, Hu (1980) recognized *Eleutherococcus* to be the earlier validly published name for *Acanthopanax*, and transferred many East Asiatic taxa of *Acanthopanax* to *Eleutherococcus*. But she overlooked the publications of Hoo & Tseng (1965, 1978), and left quite a lot of taxa in *Acanthopanax* which were transferred by Ohashi in 1987 in a new and revised system of *Eleutherococcus*. Zhang and Liu (1988) published new combinations for four taxa of Chinese *Eleutherococcus*. But unfortunately three of their combinations were predated by Ohasi (1987). Since the generic name *Acanthopanax* has never been proposed to conserve against *Eleutherococcus*, transfers of taxa from that genus to the latter are necessary. In this paper, new combinations are published for those taxa still remaining in *Acanthopanax* in the Chinese flora.

1. **Eleutherococcus baoxinensis** (X.P. Fang et C.K. Hsieh) Hsu et S.L. Pan, comb. nov. *Acanthopanax baoxinensis* X.P. Fang et C.K. Hsieh, Bull. Bot. Res. 7(4): 89, fig. 2. 1987.

2. **Eleutherococcus cissifolius** (Griff. ex Seem.) Nakai var. **glaber** (Y.R. Li) Hsu et S.L. Pan, comb. nov. *Acanthopanax cissifolius* (Griff. ex Seem.) Harms var. *glaber* Y.R. Li, Acta Bot. Yunnan. 2(1):107. 1980.

3. **Eleutherococcus nanpingensis** (X.P. Fang et C.K. Hsieh) Hsu et S.L. Pan, comb. nov. *Acanthopanax nanpingensis* X.P. Fang et C.K. Hsieh, Bull Bot. Res. 7(4):87, fig. 1. 1987.

4. **Eleutherococcus wilsonii** (Harms) Nakai var. **pilosulus** (Rehd.) Hsu et S.L. Pan, comb. nov. *Acanthopanax giraldii* Harms var. *pilosulus* Rehd., J. Arnold Arbor. 9:99. 1928. *E. giraldii* (Harms) Nakai var. *pilosulus* (Rehd.) S.Y. Hu, J. Arnold Arbor. 61:109. 1980. *A wilsonii* Harms var. *pilosulus* (Rehd.) X.P. Fang et C.K. Hsieh, Bull. Bot. Res. 7(4):90. 1987.

   Fang and Hsieh (1987) considered this variety belongs to *Acanthopanax wilsonii* Harms rather than to *A. giraldii* Harms. The present authors are in favor of their suggestion.

5. **Eleutherococcus giraldii** (Harms) Nakai var. **villosus** (Y.R. Li) Hsu et S.L. Pan, comb. nov. *Acanthopanax yui* H.L. Li var. *villosus* Y.R. Li, Fl Yunnan. 2:479. 1979.

   Shang (1985) considered *Acanthopanax yui* Li conspecific with *A. giraldii* Harms. The present combination is based on Shang's treatment.

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BOOK NOTICES

SMITH, NIGEL J.H., J.T. WILLIAMS, DONALD L. PLUCKNETT, and JENNIFER P. TALBOT. 1992. **Tropical Forests and their Crops.** (ISBN 0-8014-2771-1, pbk). Comstock Publishing Associates, a Division of Cornell University Press, Ithaca, NY. $27.95 (pbk), $69.95 (hbk). 568 pp.

"Many cultivated plants important for food and income in developing countries arose in tropical forests." A number of these plants are the subjects of this book, grouped into "Beverage and confectionery crops" (e.g., coffee, cacao); "Major fruits" (e.g., mango, citrus, pineapple); "Regional fruits" (e.g., durian, rambutan); "Rubber, oils, and resins" (e.g., oil palm, tropical pines); "Daily bread" (e.g., bananas, breadfruit); "Fuelwood, fodder, and woody grasses" (leucaena and bamboo); "Spices and natural food colorants" (e.g., clove, cinnamon, annatto); and "Nuts" (cashew, Brazil nut, macadamia). Among the data given for these crops are history, evolution, domestication, spread, genetic resources, gene pools, gene banks, germplasm collection, breeding challenges, conservation—not all of these for each crop. Additional chapters discuss the search for new plants to domesticate and the need for and strategies of conservation. Most entries in the 50-page list of "References" are post-1950 (largely from the 1980s). The book is illustrated with black-and-white photos and a few line drawings and is well indexed.—*John W. Thieret.*

NATIONAL RESEARCH COUNCIL. 1993. **Vetiver Grass. A Thin Green Line against Erosion.** (ISBN 0-309-04269-0, pbk). National Academy Press, Washington, DC. No price given. 171 pp.

Vetiver, *Vetiveria zizanioides*, has long been cultivated as the source of essential oil of vetiver used in perfumes and soaps. That it is also a grass of much promise for controlling soil erosion in warm areas is being increasingly realized. Hedges of this deep-rooted, robust, densely cespitose plant create impressive "botanical dams" strong enough to retard runoff. Although its use as a hedge plant is not new, it has recently come much into the limelight. This book offers an excellent summary on vetiver: biology, past use, current research, and future prospects. Appendix A highlights "some environmental horrors and points to the role that vetiver might play in alleviating them"; Appendix B, "Other potential vetivers," gives data on other grasses and some shrubs and trees that might be useful in erosion control; Appendix C has selected readings; and Appendix D lists worldwide research contacts. This book and the World Bank's practical handbook *Vetiver grass* (noted in *Sida* 15: 558. 1993) are a most valuable pair for anyone wanting information on this grass.—*John W. Thieret.*

NOMENCLATURAL HISTORY AND TAXONOMIC STATUS OF *ECHINACEA ANGUSTIFOLIA*, *E. PALLIDA*, AND *E. TENNESSEENSIS* (ASTERACEAE)

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ABSTRACT

A problem exists in the literature concerning the application of correct names to *Echinacea angustifolia* DC., *E. pallida* (Nutt.) Nutt., and *E. tennesseensis* (Beadle) Small. We review and clarify the past confusion concerning the nomenclatural history of these three taxa from 1753 to 1991. The contrasting views of A. Cronquist and R.L. McGregor on the taxonomic status of *E. angustifolia*, *E. pallida*, and *E. tennesseensis* are briefly discussed. Based on various types of evidence, these three taxa should be recognized as distinct species; thus, McGregor's view is accepted.

RESUMEN

Existe un problema en la bibliografía respecto a la aplicación de los nombres correctos a *Echinacea angustifolia* DC., *E. pallida* (Nutt.) Nutt., y *E. tennesseensis* (Beadle) Small. Se revisa y clarifica la confusión pasada relativa a la historia nomenclatural de estos tres taxa desde 1753 a 1991. Los diferentes puntos de vista de A. Cronquist y R.L. McGregor sobre el estatus taxonómico de *E. angustifolia, E. pallida,* y *E. tennesseensis* se discuten brevemente. En base a evidencias de varios tipos, estos tres taxa deben ser reconocidos como especies distintas. Así pues, se acepta el punto de vista de McGregor.

INTRODUCTION

In a recent study of the comparative ecology of the three closely-related species, *Echinacea angustifolia* DC., *E. pallida* (Nutt.) Nutt., and *E. tennesseensis* (Beadle) Small (Snyder 1991), we encountered considerable confusion in the literature concerning the application of the correct names to these three species. For example, several Latin names have been applied to each of these taxa, including the same name to different taxa and different names to the same taxon. Thus, it was evident that a knowledge of the nomenclatural history of these species, whose geographical distribution is well documented (McGregor 1968c), was required to accurately interpret the literature. The purpose here is to (1) present a summary of the history of the nomenclature of *E. angustifolia*, *E. pallida*, and *E. tennesseensis*, and (2) compare the views of A. Cronquist and R.L. McGregor on the taxonomic status of the three taxa.

NOMENCLATURAL HISTORY

A summary of the nomenclatural history of the three *Echinacea* taxa from 1753 to 1991 is presented in Table 1. The material in the table for which references are

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TABLE 1. Summary of the nomenclatural history of *Echinacea angustifolia*, *E. pallida*, and *E. tennesseensis*.

1753	Linnaeus described *Rudbeckia purpurea* ▸ *Rudbeckia purpurea* L., the type species of the genus *Echinacea*.
1790	Necker described the genus *Brauneria* (no species mentioned) ▸ *Brauneria* Necker.
1794	Moench described the genus *Echinacea* based on Linnaeus' *Rudbeckia purpurea* ▸ *Echinacea* Moench.
1834	T. Nuttall (1834) described *Rudbeckia pallida* ▸ *Rudbeckia pallida* Nutt.
1836	A. DeCandolle described four species of *Echinacea*, one of which was *E. angustifolia* ▸ *Echinacea angustifolia* DC.
1841	T. Nuttall (1841) transferred *Rudbeckia pallida* Nutt. to *Echinacea* → *Echinacea pallida* (Nutt.) Nutt., and also placed *Echinacea angustifolia* DC. in synonymy with *E. pallida*, often written as *Echinacea pallida* Nutt. (e.g., Small 1933; Fernald 1950; Cronquist 1952, 1955; Gleason and Cronquist 1963, 1991; Steyermark 1963; Hartley 1966; Radford et al. 1968; Barker 1969; Hitchcock and Cronquist 1973; Swink and Wilhelm 1979; Mohlenbrock 1986).
1841	T. Nuttall (1841) described *Echinacea sanguinea* ▸ *Echinacea sanguinea* Nutt.
1841–94	Thinking that *E. angustifolia* DC. and *E. pallida* (Nutt.) Nutt. were synonyms, authors of many floristic works published during this period used the name *E. angustifolia* for *E. pallida* [e.g., Torrey and Gray 1842; Darby 1857; Woods 1872; Brendel 1887; Chapman 1887; Watson and Coulter 1889; also eds. 2–5 of Gray's manual (1856–1867)].
1894	Britton (1894) made the combination *Brauneria pallida* (Nutt.) Britton, which included *Rudbeckia pallida* Nutt. [= *Echinacea pallida* (Nutt.) Nutt.] and *E. angustifolia* DC. as synonyms.
1898	Britton and Brown (1898) included *Rudbeckia pallida* Nutt. [= *E. pallida* (Nutt.) Nutt.] and *E. angustifolia* under the name *Brauneria pallida* (Nutt.) Britton .
1898	Thinking that the long-rayed *E. pallida* (Nutt.) Nutt. was *E. angustifolia* DC., and unfamiliar with the true *E. angustifolia* DC. (Fernald 1900), Beadle (1898) described *Brauneria tennesseensis* ▸ *Brauneria tennesseensis* Beadle, which previously had been included in *E. angustifolia* DC. (e.g., Gattinger 1887). One wonders if Beadle would have described *E. tennesseensis* if Britton (1894) had not made the nomenclatural blunder (cf. Fernald 1900).
1900	Fernald (1900) recognized that *E. pallida* and *E. angustifolia* were different species, placed *E. sanguinea* Nutt. in synonymy with *E. pallida*, and *Brauneria tennesseensis* Beadle in synonymy with *E. angustifolia* DC.
1900	Heller described *Brauneria angustifolia* from Texas, the description of which matched (and is a synonym of) *E. angustifolia* DC. ▸ *Brauneria angustifolia* Heller, which often has been designated as *Brauneria angustifolia* (DC.) Heller (e.g., Britton 1901; Rydberg 1906; Robinson and Fernald 1908; Shimek 1911; Blake 1928; Stevens 1950).
1901	Britton (1901) recognized that he had included the names of two distinct taxa under *Brauneria pallida* (Britton 1894; Britton and Brown 1898), and thus used the names *Brauneria pallida* (Nutt.) Britton and *B. angustifolia* (DC.) Heller to refer to these taxa. These names continued to be used in editions 2 and 3 of Britton's manual (Britton 1905, 1907).
1901	Gattinger (1901), apparently following Britton and Brown (1898), used the name *Brauneria pallida* (Nutt.) Britton for *Brauneria tennesseensis* Beadle, which previous to Beadle's (1898) description of this new species had been assumed to be the true *Echinacea* (*Brauneria*) *angustifolia* DC. of the western prairies and plains (e.g., Gattinger 1887).
1903	Small (1903) recognized *Brauneria pallida* (Nutt.) Britton, *B. angustifolia* (DC.) Heller, and *B. tennesseensis* Beadle as distinct species.
1908	In the seventh edition of Gray's Manual, Robinson and Fernald (1908) recognized that *E. pallida* was a separate species from *Echinacea* (*Brauneria*) *angustifolia* ▸ *Brauneria angustifolia* (DC.) Heller (including Tennessee material, i.e., *B. tennesseensis*) and *B. pallida* (Nutt.) Britton.
1913	Britton and Brown (1913) recognized *Echinacea pallida* (Nutt.) Britton and *E. angustifolia* DC. as separate species.
1913	Small (1913) again recognized *Brauneria pallida* (Nutt.) Britton, *B. angustifolia* (DC.) Heller, and *B. tennesseensis* Beadle as distinct species.
1929	Blake (1929) accepted *Echinacea* rather than *Brauneria*, and made *Brauneria tennesseensis* Beadle a variety of *E. angustifolia* DC. ▸ *E. angustifolia* DC. var. *tennesseensis* (Beadle) Blake.

TABLE 1. continued

1930	Johns (1930) recognized *Brauneria pallida* (Nutt.) Britton and *Brauneria angustifolia* (DC.) Heller as separate taxa.
1932	Rydberg (1932) recognized *Echinacea pallida* (Nutt.) Britton and *E. angustifolia* DC. as distinct species.
1933	Small (1933) made the combination *Echinacea tennesseensis* (Beadle) Small based on *Brauneria tennesseensis* Beadle.
1942	Steyermark (1942) described *Echinacea pallida* Nutt. forma *albida* Steyerm., which McGregor (1968c) put in synonymy with *E. pallida* (Nutt.) Nutt. However, this white form may have been described from plants of *E. simulata* McGregor. McGregor (1968c) has dots for *E. simulata*, but not for *E. pallida*, in the counties in southeastern Missouri where Steyermark (1963) has symbols for forma *albida*. According to R.L. McGregor (personal communication), "... white-rayed forms are found in *E. angustifolia*, *E. pallida*, *E. simulata*, and *E. purpurea*." We have seen a white-rayed form of *E. simulata* in Trigg County in western Kentucky and of *E. tennesseensis* in Wilson County, Tennessee.
1950	In the eighth edition of Gray's manual, Fernald (1950) used the names *Echinacea angustifolia* DC. and *E. pallida* Nutt. The range given for *E. angustifolia* does not include Tennessee, and no mention is made of *E. tennesseensis*.
1952	Cronquist (1952) did not list *E. angustifolia* separately, presumably because he did not think that the taxon occurred within the Britton and Brown manual range (R.L. McGregor, personal communication). However, under *E. atrorubens* Nutt., he made the comment "Similar to *E. angustifolia*."
1955	A. Cronquist (1955) reduced *E. angustifolia* to a variety of *E. pallida* → *E. pallida* (Nutt.) Nutt. var. *angustifolia* (DC.) Cronq. Hitchcock and Cronquist (1973), Cronquist (1980), and Gleason and Cronquist (1991) maintained this classification.
1958	On page 550 in the appendix of the second (1958) and subsequent printings of *The New Britton and Brown Illustrated Flora*, Cronquist (1958) stated that, "The Great Plains phase of *E. pallida*...may be recognized as var. *angustifolia* (DC.) Cron...."
1959	The question on *Echinacea vs. Brauneria* was settled at the ninth International Botanical Congress in Montreal, when Necker's 1790 name *Brauneria* was considered illegitimate. As *Echinacea* was the first validly published name, it took priority over *Brauneria* and became the genus name.
1961	W. J. Dress (1961) maintained *E. angustifolia* and *E. pallida* as separate species. However, he did not recognize *E. tennesseensis*, as he stated that "... it [*E. angustifolia*] also occurs in Tennessee.
1963	In the appendix added to the third printing of *Handbook of North Dakota Plants* (Stevens 1963), *Brauneria angustifolia* (DC.) Heller is changed to *Echinacea angustifolia* DC.
1968	McGregor (1968a) described *Echinacea speciosa* McGregor. This name was applied to plants of *E. pallida* (Nutt.) Nutt. in northcentral AR, southeast MO, southern IL, and westcentral KY with yellow pollen and $n = 11$, in contrast to *E. pallida* (Nutt.) Nutt. which has white pollen and $n = 22$. However, since the binomial *E. speciosa* already had been used [synonym of *Echinacea purpurea* (L.) Moench], McGregor (1968b) used the specific epithet *simulata* to describe the new species → *E. simulata* McGregor. According to Smith (1978, 1988), it is difficult to determine pollen color in herbarium specimens, and thus fresh pollen is needed to distinguish these two species in the field, since otherwise they are difficult to separate taxonomically (Smith 1973).
1968	McGregor (1968a) described a new variety of *E. angustifolia* DC. → *E. angustifolia* DC. var. *strigosa* McGregor; typical variety becoming *E. angustifolia* DC. var. *angustifolia*.
1970	McGregor's (1970) treatment of *Echinacea* species in the Texas flora is sensu McGregor 1968c.
1980	A. Cronquist (1980) did not recognize *E. simulata* McGregor as a distinct taxon from *E. pallida* (Nutt.) Nutt. var. *pallida*, or *E. angustifolia* var. *strigosa* as a distinct taxon from *E. pallida* var. *angustifolia*; suggested that *E. sanguinea* Nutt. should be treated as a variety of *E. pallida*; and considered *E. tennesseensis* (Beadle) Blake "an eastern outlier" of *E. pallida* (Nutt.) Nutt. var. *angustifolia* (DC.) Cronq.
1981	In a letter (dated 27 February 1981) to J. M. Baskin, R.L. McGregor states, "I know *angustifolia* quite well and based on my observations I just cannot merge the two [*E. angustifolia* and *E. tennesseensis*] together as Cronquist insists must be done."

TABLE 1. continued

1986	McGregor's (1986) treatment of *Echinacea* species of the Great Plains is sensu McGregor 1986c.
1987–90	Bauer and associates demonstrated that *E. angustifolia* and *E. pallida* can be distinguished by differences in the chemical constituents in the roots (Bauer and Wagner 1987; Bauer et al., 1988; Bauer and Remiger 1989), but that the alkamides and caffeic acid derivatives in *E. angustifolia* and *E. tennesseensis* "... appear to be very similar" (Bauer et al. 1990).
1989	Gandhi and Thomas (1989) reduced *E. sanguinea* to a variety of *E. pallida* ▸ *E. pallida* (Nutt.) Nutt. var. *sanguinea* (Nutt.) Gandhi & Thomas.
1990	Hatch *et al.* (1990) used the combination *Echinacea pallida* (Nutt.) Nutt. var. *strigosa* (R.L. McGreg.) Gandhi, based on *E. angustifolia* DC. var. *strigosa* R.L. McGregor.
1991	Cronquist (Gleason and Cronquist 1991) continued to recognize *angustifolia* as a variety of *E. pallida*, and suggested that *E. simulata* perhaps should be recognized as another variety of *pallida*. He states that, "An eastern outlier of var. *angustifolia*, in the cedar glades of c. Tenn., has been called *E. tennesseensis*."
1993	In a comparative study of the population genetics of *E. angustifolia* var. *angustifolia* and *E. tennesseensis*, Baskauf (1993) concluded that, "*E. tennesseensis* and *E. angustifolia* are genetically distinct taxa."

not cited was taken from Fernald (1900), Sharp (1935), Dress (1961), McGregor (1968c) and/or Foster (1984).

VIEWS OF CRONQUIST AND MCGREGOR

Authors of recent systematic works that include one or more of the three *Echinacea* species are divided between those who follow the taxonomic views of Cronquist (1955, 1980)—e.g., Scoggan (1979), Gandhi and Thomas (1989), and those who follow McGregor (1968c)—e.g., Van Bruggen (1976), Mohlenbrock (1986), Dorn (1988), Yatskievych and Turner (1990), and Taylor and Taylor (1991). A comparison of the views of McGregor and Cronquist on the taxonomic status of *E. angustifolia*, *E. pallida*, and *E. tennesseensis* is presented in Table 2. Whereas Cronquist recognizes one species, *E. pallida*, with three varieties, McGregor recognizes five species and one additional variety, *E. angustifolia* var. *strigosa*. Thus, Cronquist does not recognize either *E. simulata* (But see next to the last item in Table 1.), *E. angustifolia* var. *strigosa*, or *E. tennesseensis* as distinct taxa.

The demonstration of chemical differences in the roots of *E. angustifolia* and *E. pallida* by Bauer and associates (cited in Table 1) lend support to McGregor's (1968c) view that these two taxa are distinct species. And although no differences were detected in the root chemistry of *E. angustifolia* and *E. tennesseensis* (Bauer et al. 1990), Baskauf (1993) convincingly demonstrated by use of allozyme electrophoresis that these two entities are genetically distinct taxa. Intraspecific genetic identities differed significantly from interspecific identity (Baskauf 1993). We conclude that *E. angustifolia*, *E. pallida*, and *E. tennesseensis* should be recognized as distinct species (sensu McGregor 1968c), based on a combination of differences found in comparative studies on the morphology, anatomy, chromosome number, geographical distribution (McGregor 1968c), root chemistry (Bauer and associates, see Table 1), and genetics (Baskauf 1993).

TABLE 2. The two current views on the taxonomic status of *Echinacea angustifolia*, *E. pallida*, and *E. tennesseensis*.

1. A. Cronquist (1955, 1980)
   Echinacea pallida (Nutt.) Nutt. var. **pallida**
      E. simulata McGregor (But see next to last item in Table 1.)
   E. pallida (Nutt.) Nutt. var. **angustifolia** (DC.) Cronq.
      E. angustifolia DC. var. *angustifolia*
      E. angustifolia DC. var. *strigosa* McGregor
      E. tennesseensis (Beadle) Small - "...an eastern outlier of var. *angustifolia* in the cedar barrens of c Tenn..." (Cronquist 1980) (Also see next to last item in Table 1.)
   E. pallida (Nutt) Nutt. var. **sanguinea** (Nutt.) Gandhi and Thomas [Varietal status of *E. sanguinea* was suggested by Cronquist (1980), and formal combination made by K. Gandhi and R. D. Thomas (1989).]

2. R.L. McGregor (1968a)
   Echinacea pallida (Nutt.) Nutt.
   E. simulata McGregor
   E. sanguinea Nutt.
   E. angustifolia DC. var. **angustifolia**
   E. angustifolia DC. var. **strigosa** McGregor
   E. tennesseensis (Beadle) Small

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SOLANUM VIARUM AND *S. TAMPICENSE* (SOLANACEAE): TWO WEEDY SPECIES NEW TO FLORIDA AND THE UNITED STATES

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ABSTRACT

Two Solanaceae, *Solanum viarum*, native to southern Brazil, Paraguay, and northern Argentina, and *S. tampicense*, native to the West Indies and Mexico to Costa Rica, are here reported for Florida and the contiguous United States. *Solanum viarum* has become a noxious weed in Florida in pasture land and *S. tampicense* has the potential to become one in wet forested habitats. A key to *S. tampicense*, *S. viarum*, and related species and the nomenclature of *S. tampicense* is given.

RESUMEN

Dos Solanaceae, *Solanum viarum* nativa del sur de Brasil, Paraguay y norte de Argentina, y *S. tampicense* nativa de las Indias Occidentales y de México a Costa Rica, se citan aquí para Florida y los Estados contiguos. *Solanum viarum* se ha convertido en una mala hierba nociva en los pastos de Florida y *S. tampicense* tiene el potencial de convertirse en otra en los hábitats forestales húmedos. Se ofrece una clave para *S. tampicense, S. viarum* y especies relacionadas así como la nomenclatura de *S. tampicense.*

Two *Solanum* (Solanaceae) species, *S. viarum* Dunal and *S. tampicense* Dunal are here reported as naturalized in Florida and the contiguous United States.

Solanum viarum is native to southern Brazil, Paraguay, and northern Argentina

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but is naturalized in the New World outside its natural range in the West Indies, Mexico, and now, Florida. It is also naturalized in the Old World in Africa and India. In India, it is sometimes known under the incorrect name *S. khasianum* C.B. Clarke, which is *S. aculeatissimum* Jacq., a species perhaps also introduced from South America. *Solanum khasianum* var. *chatterjeeanum* Sen Gupta, also of India, is a synonym of *S. viarum* (Babu 1971, Nee 1991).

Solanum viarum was apparently first collected in Florida and the contiguous United States in Glades County in January 1988 and subsequently in Okeechobee and Polk counties the same year. The plants were found growing in pastures, along fence rows, and in other open disturbed sites (Fig. 1). The species is aggressive, forming near monocultures in some situations. Based on reports by IFAS County Extension Agents, an estimated 150,000 acres in southern Florida are infested with *S. viarum*. The species is typically found in soils belonging to the order of Spodosols (nearly level, somewhat poorly drained soils with a spodic horizon 1–2 m below the soil) in Florida. When growing in pasture land, the foliage is generally not grazed by cattle, probably because it is heavily armed with spines and glandular hairs although cattle will sometimes eat the unpalatable (bitter) fruit which contains the glycoalkaloid solasodine (Mullahey et al. 1993). The species has rapidly become a noxious, upland weed in many places, although its opportunistic adaptations may restrict it to disturbed areas. The rapid spread of the species in Florida is apparently due to it being transported from pasture to pasture in hay and farm machinery.

Description of *Solanum viarum*

Subshrubs to 1 m tall; stems much branched at and above the base, viscid-pubescent with a mixture of stellate trichomes and simple, glandular and nonglandular trichomes, and with straight, laterally compressed, broad-based spines to 2 cm long. Leaf blades ovate-triangular, 8–12(15) cm long, 5–10(12) cm wide, sinuate-lobed, the lobes subobtuse or subacute, both surfaces viscid-pubescent with glandular and non-glandular trichomes mixed with stellate trichomes, armed on the midrib and minor veins with straight spines; petioles 2–9 cm long. Inflorescences axillary, of 1–3 fascicles of 1- to 3-flowered cymes; calyx 4–7 mm long, 5-lobed to about the middle, often with spines, the lobes triangular-ovate, 3–6 mm long; corolla 1.5–2.7 cm in diameter, white, deeply 5-lobed, the lobes broadly lanceolate, 8–12 mm long, recurved, apex acute to mucronate, outer surface pubescent with glandular and nonglandular trichomes; filaments ca 1 mm long; anthers linear-lanceolate, 8–10 mm long; style 1, exceeding the stamens at maturity; stigma capitate, ovary globose. Fruits globose, (1.5)2–3 cm in diameter, smooth, glabrous, the immature fruit green with white mottling, yellow at maturity; peduncle stout, 1.5–2 cm long; seeds numerous, compressed, ovate-pyriform, ca 2 mm long, surface brown, very minutely rugulose. (Figs. 1 & 2).

FIG. 1. *Solanum viarum* Dunal. Top: large population in cow yard (Hardee Co., Florida). Bottom: habit.

Specimens examined. FLORIDA. **Desoto Co.:** 0.5 mi E of Ft. Ogden, E of FLA 17 on FLA 761, 1 Oct 1992, *DeLaney 1921* (USF). **Glades Co.:** N side of US 27, 2 mi W of FLA 720, ca 4 mi W of the Clewston K-Mart, T43S, R33E, Sect. 11, 7 Jan 1988, *Orsenigo s.n.* (FLAS); N side of US 27, 2 mi W of FLA 720, ca 4 mi W of the Clewston K-Mart, T43S, R33E, Sect. 11, 8 Mar

FIG. 2 *Solanum viarum* Dunal. Top: flowers. Bottom: immature fruit.

1989, *Orsenigo s.n.* (FLAS). **Hardee Co.:** 1 mi N on SR 636 (Steve Roberts Special) on Kelly Roberts NE, T34S, R26E, Sect. 24, 6 May 1989, *DeLaney 1912* (USF). **Hendry Co.:** FLA 29, Felda, 6 Dec 1990, *Townsend s.n.* (FLAS). **Highlands Co.:** Arbuckle Creek Road, ca 8 mi E of SR 17A, T34S, R30E, Sect. 27, 6 May 1989, *DeLaney 1913* (USF); SR 66, ca 1 mi W of Sparta Road,

T35S, R29E, Sect. 30, 6 May 1989, *DeLaney 1914* (USF). **Lee Co.**: along N side of Colonial Drive ca 1/2 mi E of I-75, 8 May 1992, *Beckner & Pagels 2705* (USF). **Manatee Co.**: along SR 62, ca 1 mi W of Duette, T33S, R22E, Sect. 19, 5 May 1992, *DeLaney 1919* (USF). **Marion Co.**: ca 1 mi N of Lake Co. line on I-75 northbound, 9 Aug 1992, *DeLaney 1920* (USF). **Okeechobee Co.**: near Basinger Cemetery off Hwy 98, 27 May 1988, *DeLaney 1617* (USF). **Polk Co.**: Lake Marion Scrub, ca 2 mi E of Lake Marion, ca 6 mi E of Haines City, T28S, R28E, Sect. 11, 16 Jun 1988, *Hansen, Wunderlin, & DeLaney 11786* (USF). **Sumter Co.**: 606 Willis Street, Wildwood, 8 Jul 1991, *Henderson s.n.* (FLAS).

Solanum tampicense is another species that appears to be recently naturalized in Florida. It was first collected in a swamp in Charlotte County in 1983 and two recent collections confirm this species as naturalized along the banks of the Peace River in DeSoto County and Fisheating Creek in Highlands County. At the latter site, the species is abundant and forms an impenetrable thicket in some areas of the floodplain. *Solanum tampicense* sets abundant fruit in Florida and has a strong potential to become a noxious weed in wet forested habitats.

Coile (1993) briefly mentions *S. tampicense* as occurring in Florida using the name *S. houstonii*, an earlier name, but a later homonym of *S. houstonii* Martyn. The complex nomenclature of *S. tampicense* is as follows:

Solanum tampicense Dunal, in de Candolle, Prodr. 13(1): 284. 1852. SYNTYPES: MEXICO. TAMAULIPAS: Tampico, *Berlandier 48* (G-DC, Morton photo 8443 not printed?, =IDC microfiche 800-61.2083:I.8); *Berlandier 115* (G-DC, =F photo 33952, =IDC microfiche 800-61.2083:I.8; ISOSYNTYPE: P!); *Berlandier 185* (G; ISOSYNTYPES: F!, TCD!).

Solanum quercifolium Miller, Gard. Dict. ed. 8, *Solanum* no. 16. 1768; non Linnaeus, Sp. Pl. 185. 1753. *Solanum houstonii* Dunal, Hist. Solan. 243. 1813; non *S. houstonii* Martyn, in Miller, Gard. Dict. ed. 9. 2: *Solanum* no. 91. 1807 (nom. illegit., based on *S. carolinense* "Mill," 1768). TYPE: MEXICO. VERACRUZ: *Houston s.n.* (BM, =XAL neg. 156!).

Solanum tampicense is similar to and sometimes confused with two other species, *S. adhaerens* Roemer & Schultes (syn.: *S. donnell-smithii* Coulter) and *S. lanceifolium*. Lawrence (1960) reported *S. donnell-smithii* Coulter, as having been "reintroduced" in 1958 from stock brought in from Costa Rica and cultivated as an ornamental in the Fort Lauderdale area. D'Arcy (1974), who considered *S. donnell-smithii* as synonymous with *S. lanceifolium* Jacq., cites Lawrence's report but did not see any Florida material for verification. From the geographic origin, this introduction was probably *S. adhaerens*, the oldest name for this common species of lowland Central America and northern South America, and often confused with the less weedy true *S. lanceifolium* Jacq. of the same region (Nee, 1993). *Solanum adhaerens* (sensu *S. lancifolium*) is considered a noxious weed in many parts of its range (e.g. D'Arcy 1973, 1974; Proctor 1984).

Description of *S. tampicense*

Scrambling shrubs to 5 m tall; stems sparsely stellate-pubescent, armed with recurved, laterally compressed, broad-based spines to 5 mm long. Leaf blades lanceolate to elliptic, 8–25 cm long, 2–7 cm wide, sinuate-lobed, sparsely

stellate-pubescent to glabrate, armed on the midrib and minor veins with recurved spines; petioles 1–3 cm long, sparsely stellate-pubescent and usually armed with recurved spines. Inflorescences axillary, (1)3- to 8-flowered umbelliform racemes; peduncles and pedicels 1–3 mm long; calyx 1–2 mm long, lobed to about the middle, often with spines; corolla white, 5–8 mm long, divided nearly to the base, sparsely pubescent on outer surface, the lobes often recurving; anthers slender, tapering to the apex, about as long as the corolla lobes; style 1, exceeding the stamens at maturity. Fruits globose, 6–10 mm in diameter, red, lustrous; seeds numerous, suborbicular, ca 2 mm long, compressed, yellowish.

Specimens examined. FLORIDA. **Charlotte Co.:** S of Punta Gorda, ca 0.4 mi W of SR 765, T42S, R23E, sect. 17, 1 Jun 1983, *Shuey 2550* (USF). **Desoto Co.:** ca 0.5 mi W of Arcadia and just N of Hwy 70, west bank of Peace River, T37S, R24E, Sect. 26, SE 1/4 of SE 1/4, 21 Dec 1991, *Mears s.n.* (USF). **Highlands Co.:** Fisheating Creek, S of SR 8, 21 Dec 1992, *DeLaney 1922* (NY, USF).

Among spiny *Solanum* in Florida, *Solanum viarum* and *S. tampicense* most closely resemble *S. capsicoides* All., *S. carolinense* L., *S. dimidiatum* Raf., *S. jamaicense* Miller, and *S. torvum* Sw. They may be distinguished by the following key:

1. Leaves sessile ..... *S. jamaicense*
1. Leaves petiolate.
   2. Leaves with simple trichomes; seeds winged ..... *S. capsicoides*
   2. Leaves with stellate or a mixture of stellate and simple trichomes; seeds not winged.
      3. Leaves a mixture of stellate trichomes and simple, glandular and nonglandular trichomes; plants viscid-pubescent to the touch ..... *S. viarum*
      3. Leaves with stellate trichomes only; plants not viscid-pubescent to the touch.
         4. Corolla lobed nearly to base, the lobes linear-lanceolate; fruit red, up to 1 cm in diameter ..... *S. tampicense*
         4. Corolla lobed 1/3–1/2 to base, the lobes deltoid; fruit yellow, over 1 cm in diameter.
            5. Tree or shrub; spines recurved ..... *S. torvum*
            5. Herb; spines straight or essentially so.
               6. Stellate trichomes on lower surface mostly 2- to 5-rayed; corolla 2–3 cm wide; calyx 5–7 mm long ..... *S. carolinense*
               6. Stellate trichomes on lower surface usually 6- to 8-rayed; corolla 3–4 cm wide; calyx 8–12 mm long ..... *S. dimidiatum*

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BOOK NOTICES

HEMMERLEY, THOMAS E. 1990. **Wildflowers of the Central South.** (ISBN 0-8265-1240-2, pbk.) Vanderbilt University Press, Nashville, TN 37212. $9.95. 121 pp.

Covering portions of Kentucky, Tennessee, Alabama, and a small bit of Mississippi, this book has color photos of about 150 species of "wildflowers," three or four per plate. Text descriptive of the plants is given on each facing page. Introductory pages discuss "Ecology of the central south," "Ecology of cedar glades," and "Identifying wildflowers." The 27 entries in the bibliography are grouped as "Popular illustrated books," "Scientific publications," and "Symposia." The index is detailed. The photos, unfortunately, are of variable quality, a few useless for identification, many quite excellent, most of average quality.—*John W. Thieret.*

A NEW SPECIES OF *ANULOCAULIS* (NYCTAGINACEAE) FROM SOUTHERN COAHUILA, MEXICO

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ABSTRACT

A new species of *Anulocaulis*, *A. hintoniorum* B.L. Turner, is described and illustrated from near Parras, Coahuila. It is related to *A. eriosolenus* but is amply distinct by a number of characters including larger flowers and smooth ellipsoid anthocarps.

KEY WORDS: Nyctaginaceae, *Anulocaulis*, Mexico.

Routine identification of Mexican plants has revealed the following novelty. Well into my independently initiated investigation of the species of *Anulocaulis*, Spellenberg's (1993) excellent taxonomic study of the genus appeared, making easier the study rendered here. Spellenberg recognized 5 species, all of them confined to arid regions of the southwestern U.S.A. and northern Mexico. The description here of *A. hintoniorum* adds a sixth well defined species to the genus.

Anulocaulis hintoniorum B.L. Turner, sp. nov. (Fig. 1)

Anulocauli eriosoleno (A. Gray) Standley similis sed perianthiis 15–16 mm longis (vs 8–9 mm) et anthocarpis 5–6 mm longis ellipsoideis laevibusque (vs 2.6–3.8 mm longis turbinatis plus minusve 5-angulatisque) differt.

Perennial viscid herbs 40–60 cm high. Roots woody at top with yesteryear's stubby stem-bases persistent, the tough lignescent portion extending for 12–24 cm below the ground surface (pers. comm. from collectors). Stems mostly single from a woody crown, the lower portion tan, minutely hispidulous to glabrate, the upper portions with internodes having a prominent viscid-red exudate encircling the stem. Leaves 2–5 pairs, disposed for 2–16 cm along the base of stem, mostly 6–12 cm long, 4–8 cm wide; petioles 1–4 cm long, hispidulous; blades thick, broadly ovate to subcordate, semisucculent or leathery, pinnately nervate, the lower surfaces with raised hipidulous red veins, the margins erose-crenulate. Inflorescence divaricately paniculate, occupying 2/3 or more of the plant, the nodes bracteate with broadly ovate, ciliate bracts 2–4 mm long, the internodes red-viscous like the stems, otherwise glabrous or nearly so. Flowers bounded beneath by 3–4 free scarious ovate bracts 2–3 mm long. Perianth 15–16 mm long, 5-lobed; tube ca 7 mm long, purplish, abruptly flaring into a purple

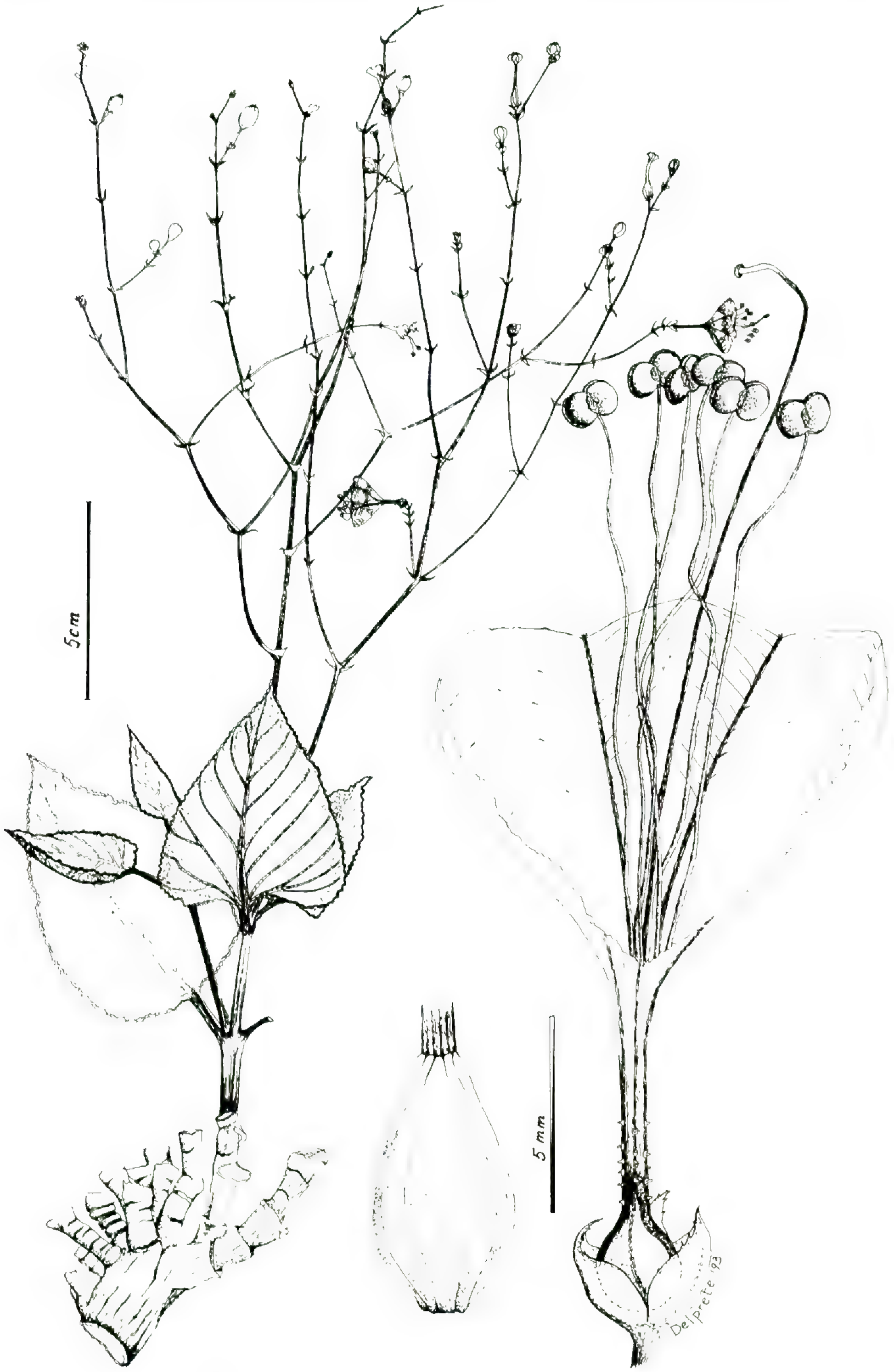

FIG. 1. *Anulocaulis hintoniorum*, from holotype.

funnelform throat 7–8 mm long, 10–15 mm across, the outer portions of the throat near apices of the lobes minutely glandular-pubescent. Stamens 5–7, exserted 3–5 mm; filaments purple, the anthers red, ca 1 mm high, 1.5 mm wide. Styles purplish, the stigma peltate. Anthocarps ellipsoid or broadly fusiform, smooth, glabrous, 5–6 mm long, ca 3.5 mm wide, weakly 10-striate, if at all.

TYPE: MEXICO. COAHUILA: Mpio. Parras, ca 14 km S of Parras, ca 25° 20'N, 102° 17'S, 1440 m, orange shale outcrops, 11 Sep 1993, *G.B. Hinton* et al. *23193* (HOLOTYPE: TEX!; ISOTYPES: MEXU!, NMC!, UC!).

Additional specimens examined: MEXICO. COAHUILA: All from same location as type material, *G.B. Hinton et al. 22693*, (TEX); immediately N of Sierra Prieta, W end of exposed ridge of shale and siltstone in area of massive outcrop ca 2.5 mi W of main road, 20 Sep 1993, *G. Nesom* 7692, with M. Mayfield and G.S. Hinton (ANSM, MEXU, NMC, TEX).

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BOOK REVIEW

BESSETTE, A.R. and A.E. BESSETTE. 1993. **Taming the Wild Mushroom, a Culinary Guide to Market Foraging.** (ISBN 292-70798-3, hbk.) University of Texas Press, P.O. Box 7819, Austin, TX 78713-7819. (512) 471-4032. $24.95. 144 pp., 95 color photographs.

The Bessettes have given us a book that in their words "...is an illustrated source book for identifying and preparing the dozen most common available cultivated and wild mushroom species sold in the market place. It is not intended as a field guide for identifying and picking wild mushrooms. We wrote it to enhance consumer awareness of the mushroom species available and to provide useful information about their selection, preservation, and preparation."

This book concentrates on 12 wild and cultivated species that are sometimes available in the marketplace. These species include the white button, a commonly cultivated mushroom (*Agaricus brunnescens*) the king bolete, a wild edible mushroom (*Boletus edulis*), oyster mushroom (*Pleurotus ostreatus*), chanterelle (*Cantharellus cibarius*), morel (*Morchella esculenta*), paddystraw mushroom (*Volvariella volvacea*), wood ear (*Auricularia polytricha*), Shiitake (*Lentinula edodes*), enokitake (*Flammulina velutipes*), white matsutake (*Tricholoma magnivelare*), black truffle (*Tuber melanosporum*), and wine-cap stropharia (*Stropharia rugosannulata*). Some of these species are not readily available in the United States and are quite expensive such as the black truffle and must be imported from foreign countries.

This book is divided into four chapters: 1. Introduction; 2. Selecting, Preserving and Cooking Mushrooms; 3. Mushrooms in the Marketplace; 4. Beyond the Marketplace. It is written in nontechnical language for the general public. Topical headings under each of the 12 species introduce salient points such as other names, description, market availability, culinary aspects, and comments and this is followed by the mushroom recipes. The bulk of the book includes 57 mushroom recipes presented on a one-page format with about half of the page a recipe and half a finished dinner-plate photograph. The photographs are excellent and will tempt you to try stuffed mushroom caps, cream of mushroom soup, mushroom fritters, Chanterelle popovers, morel sauce, dragon's mist soup, tropical fruit salad, shiitake frittata, stir-fry beef with enokitake mushrooms, scallops and white matsutake with fennel, easy truffle cheese spread and truffle butter. Somewhere under each species should have been included the range of cost if sold by the pound as fresh produce or as a processed canned product. Some of the more highly prized mushrooms used in gourmet cooking such as the black truffle may be priced beyond the pocketbook of the general public.

Consumption of cultivated and wild edible mushrooms is becoming increasingly more popular in the United States. The mushroom as a food item is particularly beneficial because of its low sodium, fat, cholesterol, and calorie content. Several recipes could have been designed as dieter's choices or several added that were low in fat or sodium to appeal to a broader public.

There is a brief section on growing your own mushrooms with a list of companies that provide mushroom kits and information for growing mushrooms at home. Appendix A is a handy list of equivalent and substitutions for common ingredients; Appendix B is a conversion table from English units into metric units for volume, weight, and temperature. A list of recommended readings is provided that concentrates on more recent publications is available in hardback which makes it more costly at $24.95 for 144 pages. Nevertheless, it should be in the kitchen of every gourmet cook who wants to impress guests with mushroom dish creations. Bon Apetit!—*Harold Keller.*

NEW COMBINATIONS IN MEXICAN MONOCOTS

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In order to validate the names of two Mexican monocot species for the publication *Las Monocotiledóneas Mexicanas, una Sinopsis Florística 1. Lista de Referencia* (A. Espejo & A.R. López-Ferrari, in preparation), the following combinations are proposed:

Brahea clara (L.H. Bailey) Espejo & López-Ferrari, comb. nov. BASIONYM: *Erythea clara* L.H. Bailey, Gentes Herb. 6:197. 1943. *Erythea roezlii* sensu L.H. Bailey (non Beccari), Gentes Herb. 4:114. 1937. TYPE: MEXICO. SONORA: San Pedro Bay, *Johnston 4340* (BH).

Uhl and Dransfield (1987) relegated *Erythea* to the synonymy of *Brahea*. In accordance, the new combination becomes necessary.

Podaechmea tuitensis (Magaña & E.J. Lott) Espejo & López-Ferrari, comb. nov. BASIONYM: *Aechmea tuitensis* Magaña & E.J. Lott, Phytologia 59:221–223. 1986.

The generic name *Podaechmea* was established by Smith and Kress (1990) with 5 species, e.g. *P. ferruginea, P. galeottii, P. lueddemanniana, P. macvaughii,* and *P. mexicana;* unfortunately they overlooked in his work *A. tuitensis.*

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BOOK REVIEW

GAUTIN, D.G., D.J. FUTUYMA and F.C. JAMES (Eds.). 1993. **Annual Review of Ecology and Systematics, Volume 24** (ISSN 006-4162). Annual Review Inc., 4139 El Camino Way, P.O. Box 10139, Palo Alto, CA 94303-0897 Hardbound $44.00 (U.S.A.) and $49.00 (elsewhere). 643 pp.

Volume 24 has 21 chapters covering a wide variety of ecological and systematic subjects. Alan Hastings, Carole L. Hom, Stephen Ellner, Peter Turchin and H. Charles J. Godfray introduce the volume with *Chaos in Ecology: Is Mother Nature a Strange Attractor?* The remaining chapters in the book are as follows: Genetics and Evolution of Phenotypic Plasticity; Patterns of Seed Longevity and Germination in the Tropical Rainforest; Hypotheses on the Orgins of Marine Larvae; The Evolution of House Mice; Congruence Between Molecular and Morphological Phylogenies; Sibling Species in the Sea; Population Genetic Consequences of Small Population Size: Implications for Plant Conservation; Avian Molecular Systematics, 1970s to 1990s; Higher Level Systematics of Eutherian Mammals: An Assessment of Molecular Characters and Phylogenetic; Phylogenetic Constraint in Evolutionary Theory: Has It Any Explanatory Power?; Reproductive Traits and Male Fertility in Plants: Empirical Approaches; The Phenology of Tropical Forests: Adaptive Significance and Consequences for Primary Consumers; Dynamic Models of Energy Allocation and Investment; Evolutionary and Ecological Aspects of Photosynthetic Pathway Variation; The Evolution of the Selfing Rate in Functionally Hermaphrodite Plants and Animals; Tertiary Mammal Evolution in the Context of Changing Climates, Vegetation, and Tectonic Events; Miniaturization of Body Size: Organismal Consequences and Evolutionary Significance; Cytonuclear Disequilibria in Hybrid Zones; Physical-Biological Interactions Influencing Marine Plankton Production and Historical Perspectives in Ecology and Evolutionary Biology: The Use of Phylogenetic Comparative Anaylses.

LUZIOLA BAHIENSIS (POACEAE): NEW TO FLORIDA

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ABSTRACT

The occurrence of three species of *Luziola* in the United States is reviewed; *L. fluitans* is widespread, whereas *L. peruviana* and *L. bahiensis* are limited in range. Collection data and a distribution map are given for the latter two, plus a detailed description of the Florida plants of *L. bahiensis*.

RESUME

Se revisa la presencia de tres especies de *Luziola* en los Estados Unidos: *L. fluitans* está ampliamente distribuida, mientras que *L. peruviana* y *L. bahiensis* tienen una distribución más limitada. Se dan datos de la recolección y un mapa de distribución para las dos últimas, además de una descripción detallada de las plantas de Florida pertenecientes a *L. bahiensis*.

KEY WORDS: Poaceae, *Hydrochloa*, *Luziola*, Florida

The genus *Luziola* comprises 12 aquatic or wetland species, three of which occur in the southeastern United States. The most widespread here, ranging from North Carolina to Texas, is *L. fluitans* (Michx.) Terrell & H. Robinson. Until 1974, this common species was known as *Hydrochloa caroliniensis* Beauv. Terrell and Robinson placed *Hydrochloa caroliniensis* in synonymy under *Luziola*, and Tucker (1988) followed their treatment.

The other two species known to occur in the United States, *L. peruviana* Gmel. and *L. bahiensis* (Steud.) Hitchc., are local and infrequently encountered. The former was probably introduced with ballast and occurs in weedy settings. The latter inhabits rather undisturbed riparian sites; specimens collected in 1859 were the basis for *L. alabamensis* Chapm. which is synonymous with *L. bahiensis*. Specimen citations for both of these rarer species are given here, and their distribution is mapped (Fig. 1).

The senior author found an unusual aquatic grass unknown to him during field surveys at Eglin Air Force Base in western Florida. It was not represented in Godfrey and Wooten (1980) or in Clewell (1985), and time did not allow additional literature search, so a specimen was sent to the junior author for

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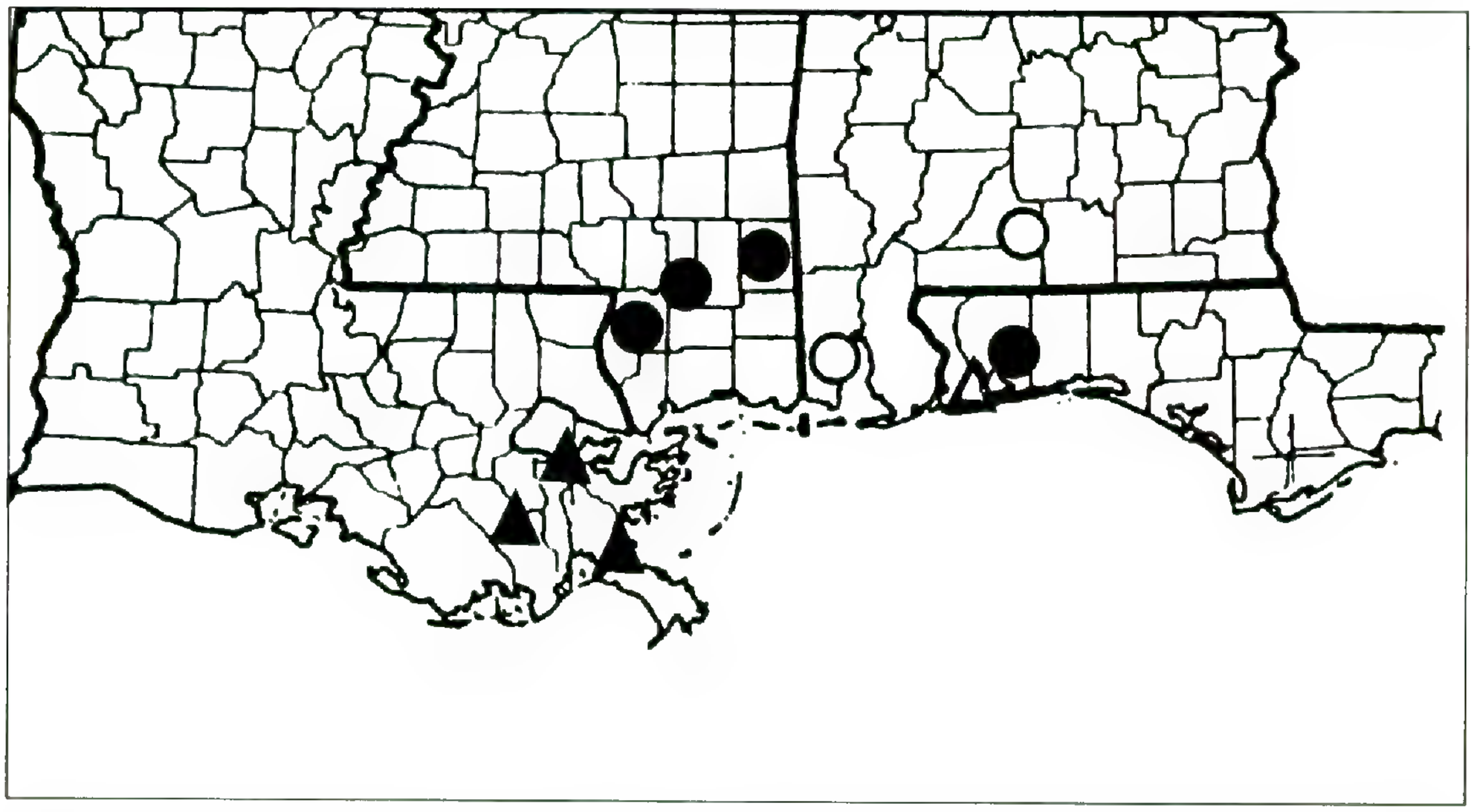

FIG. 1. Distribution of selected *Luziola* species in the southeastern United States; closed symbols are recent collections, and open symbols represent historical collections (over 90 years old). Circles = *L. babiensis*; triangles = *L. peruviana*.

identification so that more could be collected if necessary. This represents the first report for *L. babiensis* in Florida. Because this species is poorly known and the Florida plants differ somewhat from published descriptions (Hitchcock 1950, Swallen 1965), a detailed description is given here.

Florida plants of *L. babiensis* are monoecious and either rooted in water (*Anderson 13839*) with short, delicate, naked rhizomes, thus forming densely compacted floating mats with erect, emergent leaves and flowering culms (appearing turf-like until stepped upon) or rooted in mud (*Anderson 13889*) with long naked rhizomes and leafy stolons, with the basal leaves and flowering culms flaccid and floating on the water; leaves on stolons to 6 cm long, 2–3 mm wide, their sheaths shorter than the internodes. Basal leaves several, to 39 cm long with long acuminate tips, 3–4 (4.5) mm wide, erect and emergent, considerably overtopping inflorescences. Flowering culms erect, each bearing one leaf up to 26 cm long with ligule 1–1.3 mm long. Staminate culms 15–20 cm long, terminal; staminate inflorescence 4–6 cm long, racemose, the pedicels spreading, single-flowered; lemmas 4–5 mm long, smooth, nerves 7–9, faint or invisible; paleas 4 mm long; stamens 6, anthers 2–2.5 mm long. Pistillate culms (8) 10–20 cm long, axillary; pistillate inflorescence 4–8 cm long, paniculate, the pedicels spreading or usually tightly appressed, each with 1–3 flowers; glumes absent; lemmas 3.5–4(4.5) mm long, prominently 11–13 nerved (appearing as compacted, somewhat wavy longitudinal corrugations), ovate to lanceolate; lemma and palea nearly equal in length and loosely enveloping the lenticular, ovate fruit (achene rather than caryopsis, see Terrell and Robinson 1974) with short, stout stylopodium bearing persistent, spreading style branches.

The floating habit of this species (*Anderson 13839*) has not been reported previously. This good-sized population (ca. 8×20 dm) was not evident during the second visit to the site; the plants were apparently washed downstream by heavy rain that occurred just after the first visit. The genus *Hydrochloa* was distinguished from *Luziola* in that plants of the former were floating aquatics that had racemose inflorescences rather than paniculate ones (Hitchcock 1950, Hall 1978). Terrell and Robinson (1974) noted that *L. fragilis* Swallen was a floating aquatic with racemose inflorescences, and they therefore merged the genera. The report here of the floating habit in *L. bahiensis* (which has racemose staminate inflorescences) adds further weight to the inclusion of *Hydrochloa* in the older genus *Luziola*.

Specimens of *L. bahiensis* examined: ALABAMA. **Conecuh Co.:** Brooklyn, Oct 1859, *J.F. Beaumont s.n.* (MO, US). **Mobile Co.:** floating stems 2–3 ft long, inundated sandy borders of rivulets in the lower pine region near the coast, Langdons Station, 10 Jun 1884, *C. Mohr s.n.* (US), 16 Jun 1884, *C. Mohr s.n.* (ALU, NY, US), shallow brooks, pine barrens, Mobile, Jun 1886, *C. Mohr s.n.* (MO, NY). FLORIDA. **Santa Rosa Co.:** floating mats along edge of Weaver Creek at Eglin Range Road 736 bridge, T1N, R27W, SW1/4 of NW1/4 Sec 35, ca. 7.5 air mi SE of Milton, 30 Jul 1992, *L. C. Anderson 13839* (FLAS, FSU, MO, NY), rooted below water surface in mud of stream bank, Weaver Creek 10 m upstream from bridge, 14 Aug 1992, *L. C. Anderson 13889* (FSU, MO, NY, USF, VDB). MISSISSIPPI. **Forrest Co.:** shallow water, mucky bottom, Hwy 49 just S of Maxie, 25 Jun 1972, *F. H. Sargent 10517* (MO); small lake E of Hwy 49, Maxie, 25 Jun 1972, *K. Rogers 8384* (Univ. S. Miss.); shallow water of stream, 2–3 mi N of Fruitland Park on old Hwy 49, 25 Jun 1972, *K. Rogers 8385* (VDB); small stream ca. 2 mi N of Maxie on old Hwy 49, 25 Jun 1972, *K. Rogers 8386* (VDB); Mixon's Swamp, 0.5 mi S of Maxie on Hwy 49, 14 Oct 1975, *J. W. Wooten 2837* (FSU); Beaver Dam at Hwy 49 crossing, 2 mi N of Maxie, 13 Oct 1976, *J. W. Wooten 2967* (Univ. S. Miss.). **Greene Co.:** shallow water of open pond and tupelo swamp, 0.3 mi N of Leaf Church on Hwy 57, 25 Sep 1972, *K.E. Rogers 8742-D* (US). **Pearl River Co.:** Poplarville, 7 Jul 1891, *S.M. Tracy s.n.* (NY).

Luziola peruviana differs from *L. bahiensis* in being generally a more robust plant with staminate and pistillate panicles on the same culm; the staminate spikelets are longer and the pistillate spikelets are shorter than those of *L. bahiensis*.

Specimens of *L. peruviana* examined: FLORIDA. **Escambia Co.:** miry grounds near Pensacola, 12 Aug 1901, *A. H. Curtis 6871* (MO, US). LOUISIANA. **Lafourche Parish:** floating in 2–3 ft water, canal 3 mi S of Lockport, 11 Jun 1981, *G.N. Moutz 5253 et al.* (LSU, NO); canal S of Lake Fields, E of Lake Long, 29 Jun 1981, *G.N. Moutz 5272 et al.* (LSU, NO). **Orleans Parish:** ponds near Mississippi River, vicinity of New Orleans, Sep 1901, *R.S. Cocks s.n.* (NO, US); Audubon Park, New Orleans, 9 May 1935, *W.T. Penfound s.n.* (NO); Audubon Park, 29 May 1935, *W.T. Penfound s.n.* (NO); Audubon Park, 7 Nov 1940, *J.W. Lancaster s.n.* (NO); shallow pond in park, Tulane, New Orleans, 13 Jun 1939, *W.A. Silveus 4234* (TEX, US). **Plaquemines Parish:** miry places along Mississippi River, July 1882, *A.B. Langois s.n.* (US); in low miry places, Pointe a la Hache, 5 Aug 1884, *A.B. Langois s.n.* (US); in ditches and miry places, Point a la Hache, 13 Sep 1885, *A.B. Langois 5* (MO, US).

The three species differ in their origins and mode of dispersal in the United States. *Luziola fluitans* is native and scattered over a wide range of aquatic habitats. *Luziola peruviana* was apparently introduced inadvertently by man and is found in coastal and/or ruderal habitats.

Luziola bahiensis could be native, or it could have introduced naturally as seed or other propagules through tropical storms and become naturalized. It inhabits rather pristine inland wetlands. Weaver Creek is a clear, seemingly unpolluted stream containing *Orontium* and *Sphagnum* in addition to the *Luziola*; it is bordered by *Acer*, *Chamaecyparis*, *Cliftonia*, *Cyrilla*, *Magnolia*, *Nyssa*, and *Taxodium*. Many threatened or endangered species occur along its banks, such as: *Drosera intermedia* Hayne, *Lilium iridollae* Henry, *Peltandra sagittifolia* (Michx.) Morong, *Platanthera blephariglottis* (Willd.) Lindl., *P. cristata* (Michx.) Lindl., *Sarracenia leucophylla* Raf., and *S. rubra* Walt. The stream system in Forrest County, Mississippi, is also clear water and relatively unpolluted (Wooten, pers. comm.).

ACKNOWLEDGMENTS

This discovery was part of a survey for rare and endangered plant species at Eglin Air Force Base, logistically supported by Florida Natural Areas Inventory and The Nature Conservancy under contract M67004-91-D-0010/Q301 from the U.S. Department of Defense.

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A CHECKLIST OF THE VASCULAR FLORA OF CONECUH COUNTY, ALABAMA

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ABSTRACT

Based upon recent field studies, 908 species and varieties of vascular plants, representing 502 genera and 148 families, are listed for Conecuh County, Alabama. The county is centrally located in the Coastal Plain Province and contains portions of the Red Hills, Lime Hills, and Pine Flatwoods subdivisions. At least 89 of the species listed (9.8%) are considered to be new county or state records, and several of these significantly extend previously reported geographic ranges. With very few exceptions, these records represent native, non-weedy taxa.

RESUMEN

En base a estudios de campo recientes se listan para el Condado de Conecuh, Alabama, 908 especies y variedades de plantas vasculares, pertenecientes a 502 géneros y 148 familias. El condado está localizad en el centro de Coastal Plain Province y contiene partes de subdivisiones de Red Hills, Lime Hills y Pine Flatwoods. Al mentos 89 de las especies listadas (9.8%) se considera que son nuevas citas para el condado o para el estado, y algunas de ellas aumentan significativamente el rango geográfico previo. Con muy pocas excepciones estas citas representan taxa nativos que no se comportan como malas hierbas.

INTRODUCTION

The state of Alabama is poorly known floristically, being the least well represented by herbarium collections among all the southeastern states (Holmgren and Keuken 1974; Holmgren et al. 1990; Freeman 1984). This lack of floristic documentation is even more acute for areas of the state that are most remote from the major universities. We concluded that the Red Hills portion of the Coastal Plain of Alabama (Harper 1943) was one of these areas, so a floristic study of mesic ravine sites in the central Red Hills area between the Alabama and Conecuh rivers was undertaken by the senior author from March, 1985, to August, 1987, as a part of his M.S. Degree program. Since a number of new collection records for Conecuh County were obtained during this study, we compiled this checklist mainly to record the additions of recently or newly documented taxa to the flora. We hope

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this checklist will stimulate further floristic studies in other poorly documented and little studied parts of Alabama.

DESCRIPTION OF CONECUH COUNTY

Conecuh County lies in central-south Alabama approximately midway between Mobile and Montgomery along Interstate Highway 65, the major route between these cities. It is about 70 miles north of the Gulf of Mexico and has an area of 854 square miles (544,634 acres or 219,876 hectares). The population was estimated to be 14,054 as of April 1, 1990 (Center for Demographic and Cultural Research, Auburn University at Montgomery, 1992). Located entirely within the Coastal Plain Province, it is drained by the Conecuh-Escambia River system which originates within Alabama and drains into the Gulf of Mexico at Pensacola, Florida. Major streams within the county (from east to west) include the Conecuh River, Sepulga River, Murder Creek, and Escambia Creek. The climate is moderated by the Gulf of Mexico, with temperatures averaging 80.7°F (27.06°C) in July and 47.3°F (8.5°C) in January. Rainfall averages 60.85 in (151.13 cm) annually and is distributed about evenly throughout the year. The growing season is 230 ± 10 days (National Weather Service Southeast Agricultural Weather Service Center, Auburn University, 1992). The three major subdivisions of the Coastal Plain Province found in the county include, from north to south, the Red Hills, the Lime Hills, and Pine Flatwoods (Harper 1943).

Although this county was settled in the early 1800s by Europeans, until recently it had not been carefully and thoroughly studied botanically. This study represents the first systematic survey of the vascular plants of Conecuh County in its entirety. The name Conecuh, of Creek Indian origin, has a botanical connotation and means "land of cane" in reference to the extensive thickets of bamboo [*Arundinaria gigantea* (Walter) Muhl.] that once lined many of the water courses in the area (Riley 1881). Bartram (1777) passed through the area on his way to Mobile from Montgomery and listed a few species. Mohr (1901) included Conecuh County in an area known as the Upper Coastal Pine Belt and also listed a few species from the county. Small (1933), author of the only manual of the southeastern flora published during this century, probably passed through the area in his travels; collections from the vicinity of Evergreen were cited by him. Also, both the main rail line and highway from Pensacola, Florida, and Mobile, Alabama, pass through this county on their way to Montgomery, Alabama. More recently the woody plants of Alabama (thus to some extent those of this county) were treated by Clark (1971) and Duncan (1975). Recent field work by the senior author was done mostly in the northern part of Conecuh County (Diamond 1987); subsequently, additional collections from other portions of the county were also obtained. Robert Kral (1966a, 1966b, 1969) of Vanderbilt University has collected extensively in south Alabama for many years. Duplicates of his

records for Conecuh County cited herein were deposited in the Auburn University Herbarium (AUA) as well as at Vanderbilt University (VDB) and elsewhere.

METHODS

To obtain a reasonably complete picture of the diversity of the flora of the county, numerous plant communities and habitats were sampled in this study. Many of these habitats showed the effects of man's activities—especially roadsides, cultivated ground, waste areas, man-made impoundments, barrow pits, railroad and power line rights-of-way, and pine plantations. Relatively undisturbed habitats included beaver ponds, steep-sided creek banks, limestone outcrops near caves, and mesic hardwood ravines. Voucher specimens of all collections were deposited at AUA with available duplicates sent (in order of priority) to VDB, University of Georgia Herbarium (GA), University of North Carolina Herbarium (NCU), Missouri Botanical Garden Herbarium (MO), and United States National Herbarium (US).

Identifications were made using primarily *Manual of Vascular Flora of the Carolinas* (Radford et al. 1968) and *Guide to the Vascular Plants of the Florida Panhandle* (Clewell 1985). The nomenclature generally follows that of Kartesz and Kartesz (1980). Author citations conform to standard forms recommended by Brummitt and Powell (1992). Other references that were useful for special groups and provided the names used herein include: Cronquist (1980) for Asteraceae; Isely (1990) for Fabaceae; Lellinger (1985) for pteridophytes; Luer (1975) for Orchidaceae; Kral (1966a) for *Xyris*; Freeman (1975) for *Trillium*; Russell (1965) for *Viola*; and Yates (1977) for *Chasmanthium*. Determinations for our *Panicum* species were made by Dr. Michel Lelong, University of South Alabama, whose assistance we gratefully acknowledge.

RESULTS AND DISCUSSION

The vascular flora of Conecuh County includes 908 species representing a total of 502 genera and 148 families based upon our collections as well as literature and herbarium searches. The largest families were Asteraceae with 103 species, Poaceae with 75 species, Fabaceae with 50 species, Cyperaceae with 33 species, Liliaceae with 31 species, and Rosaceae with 29 species. Lelong (1977) reported 876 species in 414 genera and 125 families in the vicinity of Mobile, Alabama. Grubbs and Fuller (1991) reported 889 species and varieties representing 435 genera and 126 families in the vascular flora of Hickman County, Kentucky. The vascular flora of Conecuh County is evidently rather diverse for a non-coastal, non-upland area.

In addition to field collections, various publications were reviewed for names of plants occurring in the county. Taxa reported by others but not collected during the period of this research, a total of 32 species, are listed herein with the reference

concerning each species cited following the entry. Since the collection sites for such species were revisited in most instances, it is possible that some of them have been extirpated from Conecuh County since their original discovery, particularly certain taxa reported many years ago.

A computerized search of the collections of the University of Alabama at Tuscaloosa was also undertaken. Specimens on file there but not collected during this project, a total of 21 species, are listed with the herbarium acronym (UNA for the Herbarium of the University of Alabama or ALU for the Mohr Herbarium) following the entry.

Names of those species that seem on the basis of available literature to represent new records for Conecuh County are preceded by an asterisk(*). Other than the monographic treatments that were used for identification (cited above), the work on woody plants by Clark (1971) and Duncan (1975), and records maintained by the Alabama Natural Heritage Program for uncommon species, few published records of plant collections for the study area were available to facilitate our decisions concerning new collection records. Several herbaceous species that are not marked with asterisks are probably reported herein for the first time for Conecuh County, but we cannot make this claim for them with certainty. Since herbarium searches were limited to AUA, UNA, and VDB, earlier collections than ours may exist elsewhere.

A total of 19 taxa represented in Conecuh County are treated in the Alabama Natural Heritage Section's Plant Inventory List (February 1993 Edition) as endangered, threatened, or of special concern in the state. None of them are federally listed at this time. The names of these taxa are presented below in alphabetical order by genus:

Apteria aphylla Nutt.
Aquilegia canadensis L. var. *australis* (Small) Munz
Botrychium lunarioides Michx.
Brickellia cordifolia Elliott
Corallorhiza wisteriana Conrad
Croomia pauciflora (Nutt.) Torr.
Epidendrum conopseum R.Br.
Isopyrum biternatum (Raf.) Torr. & A.Gray
Lycopodium cernuum L.
Ophioglossum crotalophoroides Walter
Quercus arkansana Sarg.
Rhapidophyllum hystrix (Pursh) H.Wendl. & Drude
Rhododendron austrinum (Small) Rehd.
Sarracenia leucophylla Raf.
Sarracenia purpurea L.
Selaginella ludoviciana A.Br.
Thelypteris hispidula (Decne) C.F.Reed var. *veriscolor* R.P. St.John in Small) Lellinger
Xyris scabrifolia R.M.Harper
Zanthoxylum clava-herculis L.

Records that constitute particularly noteworthy extensions of geographical ranges are annotated with relevant location data in the form of township, range, and section coordinates following the name. No more precise location data are offered because of the scarcity of many of these plants and their vulnerability to over-collecting. We will provide label data or loans of documentary material to qualified researchers upon request. In a few cases we have made further commen-

tary concerning the basis for nomenclature presented or cite some reference that pertains to just one or a few species. Family names are arranged alphabetically, and within each family the generic names and species epithets, respectively, are also in alphabetical order.

ANNOTATED CHECKLIST

ACANTHACEAE
Hygrophila lacustris (Schltdl. & Cham.) Nees
Justicia americana (L.) Vahl
Ruellia caroliniensis (J.F.Gmel.) Steud.
ACERACEAE
Acer floridanum (Chapm.) Pax
**A. negundo* L.
A. rubrum L.
AIZOACEAE
Mollugo verticillata L.
ALISMATACEAE
Sagittaria australis (J.G.Sm.) Small
S. latifolia Willd.
AMARANTHACEAE
Amaranthus hybridus L.
A. spinosus L.
Froelichia floridana (Nutt.) Moq.
AMARYLLIDACEAE
Hymenocallis occidentalis (Leconte) Kunth
Manfreda virginica (L.) Rose
Zephyranthes atamasco (L.) Herb.
ANACARDIACEAE
Rhus copallina L.
R. glabra L.
Toxicodendron radicans (L.) Kuntze
**T. toxicarium* (Salisb.) Gillis
**T. vernix* (L.) Kuntze
ANNONACEAE
**Asimina parviflora* (Michx.) Dunal
APIACEAE
Angelica venenosa (Greenway) Fernald
Chaerophyllum tainturieri Hook.
Ciclospermum leptophyllum (Pers.) Sprague
Cicuta maculata L.
Daucus carota L.
D. pusillus Michx.
Eryngium integrifolium Walter
E. prostratum Nutt.
E. yuccifolium Michx.
Hydrocotyle umbellata L. (UNA)
H. verticillata Thunb.
Oxypolis rigidior (L.) Raf.
Sanicula canadensis L.
**Spermolepis divaricata* (Walter) Britton
S. echinata (Nutt.) A.Heller
Thaspium trifoliatum (L.) A.Gray
APOCYNACEAE
Apocynum cannabinum L.
**Trachelospermum difforme* (Walter) A.Gray
AQUIFOLIACEAE
Ilex ambigua (Michx.) Torr. [Clark 1971]
I. coriacea (Pursh) Chapm.
I. decidua Walter
I. glabra (L.) A.Gray
**I. myrtifolia* Walter
I. opaca Aiton
I. verticillata (L.) A.Gray
I. vomitoria Aiton
ARACEAE
Arisaema dracontium (L.) Schott
A. triphyllum (L.) Schott
Orontium aquaticum L.
Peltandra virginica (L.) Schott
ARALIACEAE
Aralia spinosa L.
ARECACEAE
Rhapidophyllum hystrix (Pursh) H.Wendl. & Drude
Sabal minor (Jacq.) Pers.
ARISTOLOCHIACEAE
Aristolochia serpentaria L.
**A. tomentosa* Sims
Hexastylis arifolia (Michx.) Small
ASCLEPIADACEAE
Asclepias amplexicaulis Sm.
A. michauxii Decne.
A. obovata Elliott
A. perennis Walter
A. tuberosa L.
A. variegata L.
Matelea gonocarpa (Walter) Shinners
ASPIDIACEAE
Athyrium filix-femina (L.) Roth var. *asplenioides* (Michx.) Farw.
Dryopteris ludoviciana (Kunze) Small
Onoclea sensibilis L.
Polystichum acrostichoides (Michx.) Schott
**Thelypteris hexagonoptera* (Michx.) Weatherby
**T. hispidula* (Decne.) C.F.Reed var. *versicolor* (R.P.St.John) Lellinger
T. kunthii (Desv.) Morton
T. ovata R.P.St.John in Small [Short 1978]

T. palustris Schott [Short 1978]
T. torresiana (Gaudich.) Alston

ASPLENIACEAE

Asplenium platyneuron (L.) Britton, Sterns & Poggenb.
A. resiliens Kunze

ASTERACEAE

**Acanthospermum australe* (Loefl.) Kuntze
Ambrosia artemisiifolia L.
A. trifida L.
Aster concolor L.
A. dumosus L.
A. lateriflorus (L.) Britton
A. paludosus Aiton
A. paternus Cronquist
A. sagittifolius Willd.
**Baccharis halimifolia* L.
Berlandiera pumila (Michx.) Nutt.
Bidens bipinnata L.
B. laevis (L.) Britton, Sterns & Poggenb.
**Brickellia cordifolia* Elliott T7N, R11E, Sec. 13-14
Cacalia lanceolata Nutt.
C. ovata Walter
Carphephorus odoratissimus (J.F.Gmel.) Herb.
Chaptalia tomentosa Vent.
Chrysopsis graminifolia (Michx.) Elliott
C. mariana (L.) Elliott
Cirsium altissimum (L.) Spreng.
C. horridulum Michx.
Conyza bonariensis (L.) Cronquist
C. canadensis (L.) Cronquist
Coreopsis basalis (F.Dietr.) S.F.Blake
C. gladiata Walter
C. grandiflora Hogg ex Sweet
C. major Walter
C. pubescens Elliott
C. tinctoria Nutt.
Eclipta alba (L.) Hassk.
Elephantopus carolinianus Willd.
E. elatus Bertol.
E. tomentosus L.
Erechtites hieracifolia (L.) Raf. ex DC.
Erigeron annuus (L.) Pers.
E. philadelphicus L.
E. strigosus Muhl. ex Willd.
E. vernus (L.) Torr. & A.Gray
Eupatorium capillifolium (Lam.) Small
E. coelestinum L.
E. compositifolium Walter
E. fistulosum Barratt
E. rotundifolium L.
Euthamia minor (Michx.) Greene
Gaillardia aestivalis (Walter) H.Rock
G. pulchella Foug.
Gnaphalium obtusifolium L.
G. purpureum L.
Helenium amarum (Raf.) H.Rock
H. autumnale L.
H. brevifolium (Nutt.) A.W.Wood
H. flexuosum Raf.
Helianthus angustifolius L.
H. annuus L.
H. heterophyllus Nutt.
H. hirsutus Raf.
H. laetiflorus Pers.
H. microcephalus Torr. & A.Gray
H. tuberosus L.
Heterotheca subaxillaris (Lam.) Britton & Rusby
Hypochoeris radicata L.
Krigia oppositifolia Raf.
Lactuca canadensis L.
L. floridana (L.) Gaertn.
Liatris elegans (Walter) Michx.
L. spicata (L.) Willd.
L. tenuifolia Nutt.
Melanthera nivea (L.) Small
Mikania scandens (L.) Willd.
Pluchea camphorata (L.) DC.
P. foetida (L.) DC. (UNA)
Polymnia uvedalia L.
Pyrrhopappus carolinianus (Walter) DC.
Rudbeckia fulgida Aiton
R. hirta L.
Senecio anonymus A.W.Wood
S. glabellus Poir.
S. obovatus Muhl. ex Willd.
S. tomentosus Michx.
Silphium compositum Michx.
S. dentatum Elliott
Solidago caesia L.
S. canadensis L.
S. gracillima Torr. & A.Gray
S. leavenworthii Torr. & A.Gray
S. microcephala (Greene) Bush
S. odora Aiton
S. rugosa Aiton
S. stricta Aiton
Soliva pterosperma (Juss.) Less.
Sonchus aspera (L.) Hill
Spilanthes americana (Mutis) Hieron.
Stokesia laevis (Hill) Greene
Taraxacum officinale Weber
Tetragonotheca helianthoides L.
Verbesina alternifolia (L.) Britton
V. aristata (Elliott) A.Heller
V. virginica L.
Vernonia angustifolia Michx.
V. gigantea (Walter) Trel. ex Branner & Coville
Xanthium strumarium L.
Youngia japonica (L.) DC.

AZOLLACEAE
Azolla caroliniana Willd.
BALSAMINACEAE
Impatiens capensis Meerb.
BERBERIDACEAE
Nandina domestica Thunb.
Podophyllum peltatum L.
BETULACEAE
Alnus serrulata (Aiton) Willd.
Betula nigra L.
Carpinus caroliniana Walter
Ostrya virginiana (Mill.) K.Koch
BIGNONIACEAE
Bignonia capreolata L.
Campsis radicans (L.) Seem. ex Bureau
Catalpa bignonioides Walter
BLECHNACEAE
Lorinseria areolata (L.) Presl
Woodwardia virginica (L.) Sm.
BORAGINACEAE
Cynoglossum virginianum L.
Heliotropium amplexicaule Vahl
H. indicum L.
Lithospermum tuberosum Rugel ex DC.
BRASSICACEAE
Capsella bursa-pastoris (L.) Medik.
Cardamine bulbosa (Schreb.) Britton, Sterns & Poggenb.
C. hirsuta L.
C. pensylvanica Muhl. ex Willd.
Dentaria laciniata Muhl. ex Willd.
Draba brachycarpa Nutt. ex Torr. & A.Gray
Lepidium virginicum L.
Raphanus raphanistrum L.
BROMELIACEAE
Tillandsia usneoides (L.) L.
BURMANNIACEAE
Apteria aphylla (Nutt.) Barnhart
CABOMBACEAE
Brasenia schreberi J.G.Gmel.
CACTACEAE
**Opuntia humifusa* (Raf.) Raf.
CALLITRICHACEAE
**Callitriche terrestris* Raf. T4N, R13E, Sec. 19
C. heterophylla Pursh
C. peploides Nutt. (UNA)
CALYCANTHACEAE
**Calycanthus floridus* L.
CAMPANULACEAE
**Campanula americana* L. T3N, R13E, Sec. 2
Lobelia cardinalis L.
L. elongata Small
L. nuttallii Roem. & Schult.
L. puberula Michx.
L. siphilitica L. (UNA)
Specularia biflora (Ruiz & Pav.) Fisch. & B.Mey.
S. perfoliata (L.) A.DC.
Wahlenbergia marginata (Thunb.) A.DC.
CAPRIFOLIACEAE
Lonicera japonica Thunb.
L. sempervirens L.
Sambucus canadensis L.
Viburnum dentatum L.
V. nudum L.
V. rufidulum Raf.
CARYOPHYLLACEAE
Cerastium glomeratum Thuill.
**Paronychia patula* Shinners
Sagina decumbens (Elliott) Torr. & A.Gray
Saponaria officinalis L.
**Silene virginica* L.
Stellaria media (L.) Vill.
Stipulicida setacea Michx.
CELASTRACEAE
Euonymus americanus L.
CERATOPHYLLACEAE
Ceratophyllum demersum L.
C. muricatum Cham.
CHENOPODIACEAE
Chenopodium album L.
C. ambrosioides L.
CISTACEAE
Lechea villosa Elliott
CLETHRACEAE
**Clethra alnifolia* L.
COMMELINACEAE
Commelina communis L.
C. virginica L.
Tradescantia ohiensis Raf.
CONVOLVULACEAE
Cuscuta compacta Juss.
Dichondra carolinensis Michx.
Ipomoea coccinea L.
I. hederacea Jacq.
I. lacunosa L.
I. pandurata (L.) G.Mey.
I. purpurea (L.) Roth
I. quamoclit L.
Jacquemontia tamnifolia (L.) Griseb.
Stylisma humistrata (Walter) Chapm.
S. patens (Desr.) Myint
CORNACEAE
**Cornus alternifolia* L.f. T7N, R11E, Sec. 13–14
C. amomum Mill. [Clark 1971]
C. florida L.
C. stricta (Lam.) Small
CUCURBITACEAE
Citrullus lanatus (Thunb.) Matsum. & Nakai
Melothria pendula L.

CUPRESSACEAE
Chamaecyparis thyoides (L.) Britton, Sterns & Poggenb.
Juniperus virginiana L.
CYPERACEAE
Bulbostylis barbata (Rottb.) C.B.Clarke
B. capillaris (L.) C.B.Clarke
Carex artitecta Mack.
C. cherokeensis Schwein.
C. folliculata L.
C. lupulina Muhl. (UNA)
C. lurida Wahlenb.
C. normalis Mack.
Cyperus brevifolius (Rottb.) Endl. ex Hassk.
C. erythrorhizos Muhl.
C. flavescens L.
C. globulosus Aublet
C. plukenetii Fernald
C. pseudovegetus Steud.
C. rotundus L.
Dichromena latifolia Baldwin ex Elliott
Dulichium arundinaceum (L.) Britton (UNA)
Eleocharis balduinii (Torr.) Chapm.
E. microcarpa Torr.
E. obtusa (Willd.) Schult.
E. tuberculosa (Michx.) Roem. & Schult.
Fimbristylis miliacea (L.) Vahl
Fuirena squarrosa Michx.
Lipocarpha maculata (Michx.) Torr.
Psilocarya nitens (Vahl) A.W.Wood
Rhynchospora caduca Elliott (UNA)
R. cephalantha A.Gray (UNA)
R. corniculata (Lam.) A.Gray
R. globularis (Chapm.) Small
R. glomerata (L.) Vahl (UNA)
R. inexpansa (Michx.) Vahl
R. intermixta C.Wright ex Sauvalle
Scirpus cyperinus (L.) Kunth
CYRILLACEAE
**Cliftonia monophylla* (Lam.) Britton ex Sarg.
Cyrilla racemiflora L.
DIOSCOREACEAE
Dioscorea villosa L.
DROSERACEAE
**Drosera brevifolia* Pursh
D. capillaris Poir.
EBENACEAE
Diospyros virginiana L.
ELAEAGNACEAE
Elaeagnus pungens Thunb.
EQUISETACEAE
Equisetum hyemale L.
ERICACEAE
Gaylussacia dumosa (Andrz.) Torr. & A.Gray
G. frondosa (L.) Torr. & A.Gray ex Torr.
Kalmia latifolia L.
Leucothoe axillaris (Lam.) D.Don
L. racemosa (L.) A.Gray
Lyonia lucida (Lam.) K.Koch
Oxydendrum arboreum (L.) DC.
**Rhododendron alabamense* Rehder T7N, R11E, Sec. 13-14
R. austrinum (Small) Rehder
R. canescens (Michx.) Sweet
R. viscosum (L.) Torr.
Vaccinium arboreum Marshall
V. ashei Rehder [Clark 1971] We acknowledge that Clark suggests that this and *V. fuscatum* may be the same as *V. corymbosum*, and the next four named "species" are all treated as under the latter name by Vander Kloet (1980). In our opinion, at least three (perhaps five) different high-bush blueberry taxa occur in this county and closely agree with the three names that follow. We certainly agree with Godfrey (1988) concerning *V. elliottii*, "which seems to me to have such distinctiveness as to be recognizable in the field at a glance."
V. atrococcum (A.Gray) A.Heller
V. corymbosum L.
V. elliottii Chapm.
V. fuscatum Aiton [Clark 1971]
V. stamineum L.
ERIOCAULACEAE
Eriocaulon decangulare L.
Lachnocaulon anceps (Walter) Morong
EUPHORBIACEAE
Acalypha gracilens A.Gray
A. ostryaefolia Riddell
Chamaesyce maculata (L.) Small
Cnidoscolus stimulosus (Michx.) Engelm. & A.Gray
Croton capitatus Michx.
C. glandulosus L. var. *septentrionalis* Müll.Arg.
Euphorbia commutata Engelm.
E. corollata L.
Phyllanthus urinaria L.
Poinsettia heterophylla (L.) Klotzsch & Garcke
Ricinus communis L.
**Sapium sebiferum* (L.) Roxb.
Sebastiania fruticosa (Bartram) Fernald
Stillingia sylvatica Garden ex L.
Tragia urens L.
T. urticifolia Michx.
FABACEAE
Albizia julibrissin Durazz.

Amorpha fruticosa L.
Apios americana Medik.
Astragalus villosus Michx.
Baptisia alba (L.) R.Br.
Chamaecrista fasciculata (Michx.) Greene
C. nictitans (L.) Moench
Centrosema virginianum (L.) Benth.
Cercis canadensis L.
Crotalaria rotundifolia (Walter) Poir.
C. spectabilis Roth
Dalea pinnata (J.F.Gmel.) Barneby
Desmodium marilandicum (L.) DC.
D. tortuosum (Sw.) DC.
Erythrina herbacea L.
Galactia macreei M.A.Curtis
G. volubilis (L.) Britton
Gleditsia triacanthos L.
Lespedeza capitata Michx.
L. cuneata (Dum.Cours.) G.Don
L. hirta (L.) Hornem.
L. procumbens Michx.
L. stuevei Nutt.
Lupinus villosus Willd.
Medicago arabica (L.) Huds.
Melilotus alba Medik.
Pueraria lobata (Willd.) Ohwi
Rhynchosia reniformis (Pursh) DC.
Robinia pseudo-acacia L.
Schrankia microphylla (Dryand.) J.F.Macbr.
Senna obtusifolia (L.) Irwin & Barneby
S. occidentalis (L.) Link
Sesbania macrocarpa Muhl. ex Raf.
S. punicea (Cav.) Benth.
Strophostyles umbellata (Muhl. ex Willd.) Britton
Stylosanthes biflora (L.) Britton, Sterns & Poggenb.
Tephrosia hispidula (Michx.) Torr. & A.Gray
T. spicata (Walter) Torr. & A.Gray
T. virginiana (L.) Pers.
Trifolium campestre Schreb.
T. carolinianum Michx.
T. dubium Sibth.
T. incarnatum L.
**T. vesiculosum* Savi
Vicia caroliniana Walter
V. lathyroides L.
V. villosa Roth ssp. *varia* (Host) Corb.
**Wisteria frutescens* (L.) Poir.
W. sinensis (Sims) Sweet
Zornia bracteata (Walter) J.G.Gmel.

FAGACEAE

Castanea dentata (Marshall) Borkh.
C. dentata (Marshall) Borkh. × *mollissima* Blume
C. pumila (L.) Mill.
Fagus grandifolia Ehrh.
Quercus alba L.
Q. arkansana Sarg.
Q. coccinea Münchh.
Q. falcata Michx.
Q. hemisphaerica Bartram
Q. incana Bartram
Q. laevis Walter
Q. laurifolia Michx.
Q. lyrata Walter
Q. margaretta Ashe
Q. marilandica Münchh.
Q. michauxii Nutt.
Q. nigra L.
Q. phellos L. [Clark 1971]
**Q. rubra* L. T7N, R11E, Sec. 13-14
Q. stellata Wangenh.
**Q. virginiana* Mill.

FUMARIACEAE

Corydalis micrantha (Engelm.) A.Gray

GENTIANACEAE

Gentiana catesbaei Walter
Sabatia campanulata (L.) Torr.
S. gentianoides Elliott

GERANIACEAE

Geranium carolinianum L.
G. maculatum L.

HALORAGACEAE

Myriophyllum brasilense Cambess.
M. laxum Shuttlew. ex Chapm.
Proserpinaca palustris L.
P. pectinata Lam.

HAMAMELIDACEAE

Hamamelis virginiana L.
Liquidambar styraciflua L.

HIPPOCASTANACEAE

Aesculus parviflora Walter
A. pavia L.

HYDROCHARITACEAE

Egeria densa Planch.

HYDROPHYLLACEAE

Hydrolea quadrivalvis Walter

HYPERICACEAE

**Hypericum brachyphyllum* (Spach) Steud.
**H. cistifolium* Lam.
H. drummondii (Grev. & Hook.) Torr. & A.Gray
H. hypericoides (L.) Crantz
H. mutilum L.
H. punctatum Lam.
H. stans (Michx.) W.P.Adams & N.Robson
Triadenum walteri (J.G.Gmel.) Gleason

ILLICIACEAE

Illicium floridanum J. Ellis

IRIDACEAE
Gladiolus papilio Hook.f.
Iris hexagona Walter
I. verna L.
Sisyrinchium mucronatum Michx.
S. rosulatum E.P.Bicknell
ISOETACEAE
**Isoetes engelmannii* A.Br.
I. engelmannii A.Br. × *flaccida* Shuttlew. ex A.Br. [Boom, 1982]
JUGLANDACEAE
Carya illinoensis (Wangenh.) K.Koch
C. ovalis (Wangenh.) Sarg.
C. pallida (Ashe) Engelm. & Graebn. [Clark 1971]
C. tomentosa (Poir.) Nutt.
Juglans nigra L.
JUNCACEAE
Juncus biflorus Elliott
J. bufonius L.
J. coriaceus Mack.
J. dichotomus Elliott
J. diffusissimus Buckley
J. effusus L.
J. marginatus Rostk.
J. megacephalus M.A.Curtis
J. polycephalus Michx.
J. repens Michx.
J. scirpoides Lam. (UNA)
J. tenuis Willd.
J. trigonocarpus Steud.
Luzula echinata (Small) F.J.Herm.
LAMIACEAE
Calamintha georgiana (R.M.Harper) Shinners
**Collinsonia canadensis* L. T7N, R11E, Sec. 13-14
Hedeoma hispidum Pursh
Hyptis alata (Raf.) Shinners
H. mutabilis (Rich.) Briq.
Lamium amplexicaule L.
Lycopus americanus Muhl. ex Barton (UNA)
L. rubellus Moench
L. virginicus L.
Monarda punctata L.
Perilla frutescens (L.) Britton
Prunella vulgaris L.
Pycnanthemum muticum (Michx.) Pers.
Salvia azurea Michx. & Lam.
S. lyrata L.
Scutellaria elliptica Muhl.
S. incana Biehler
S. integrifolia L.
Stachys floridana Shuttlew.
Trichostema dichotomum L.
LAURACEAE
Lindera benzoin (L.) Blume [Clark 1971]
Persea borbonia (L.) Spreng.
Sassafras albidum (Nutt.) Nees
LEMNACEAE
Lemna aequinoctialis Welw.
L. valdiviana Phil. (UNA)
Spirodela polyrrhiza (L.) Schleid.
LENTIBULARIACEAE
**Pinguicula primuliflora* C.E.Wood & R.K.Godfrey
Utricularia biflora Lam. (UNA)
U. gibba L.
U. juncea Vahl
**U. purpurea* Walter
LILIACEAE
Aletris farinosa L.
**A. obovata* Nash
Allium bivalve (L.) Kuntze
A. canadense L.
A. mobilense Regel
A. vineale L.
Amianthium muscaetoxicum (Walter) A.Gray
Asparagus officinalis L.
Chamaelirium luteum (L.) A.Gray
Ipheion uniflorum (Lindl.) Raf.
Lilium longiflorum Thunb.
L. michauxii Poir.
L. superbum L.
**Medeola virginiana* L. T5N, R11E, Sec. 36
Polygonatum biflorum (Walter) Elliott
Smilax bona-nox L. [Duncan 1975]
S. ecirrhata (Engelm. ex Kunth) S.Watson
S. glauca Walter
S. laurifolia L.
S. pumila Walter
S. rotundifolia L. [Duncan 1975]
S. smallii Morong
S. walteri Pursh [Clark 1971]
Tofieldia racemosa (Walter) Britton, Sterns & Poggenb.
**Trillium catesbaei* Elliott T7N, R12E, Sec 19-20. This is the westernmost locality known for this species.
T. decipiens J.D.Freeman
T. maculatum Raf.
T. stamineum Harb.
T. underwoodii Small
Uvularia perfoliata L.
Yucca filamentosa L.
LINACEAE
Linum striatum Walter
L. virginianum L.
LOGANIACEAE
**Buddleja lindleyana* Fortune

Cynoctonum mitreola (L.) Britton
C. sessilifolium (Walter) J.St.-Hil.
**Gelsemium rankinii* Small
G. sempervirens (L.) J.St.-Hil.
Polypremum procumbens L.
Spigelia marilandica L.

LORANTHACEAE
**Phoradendron serotinum* (Raf.) M.C.Johnst.

LYCOPODIACEAE
Lycopodium alopecuroides L.
**L. appressum* (Chapm.) F.E.Lloyd & Underw.
**L. carolinianum* L.
**L. cernuum* L.
**L. prostratum* R.M.Harper

LYTHRACEAE
**Cuphea carthagenensis* (Jacq.) J.F.Macbr.
Lagerstroemia indica L.
Rotala ramosior (L.) Koehne

MAGNOLIACEAE
Liriodendron tulipifera L.
Magnolia acuminata (L.) L.
M. grandiflora L.
**M. macrophylla* Michx.
M. pyramidata Bartram
**M. tripetala* L.
M. virginiana L.

MALVACEAE
Hibiscus aculeatus Walter
Malvariscus arboreus Cav.
Modiola caroliniana (L.) G.Don
**Sida elliottii* Torr. & A.Gray T7N, R11E, Sec. 13-14
S. rhombifolia L.

MAYACACEAE
Mayaca aubletii Michx.

MELASTOMATACEAE
Rhexia alifanus Walter
**R. lutea* Walter
R. mariana L.
R. petiolata Walter [Kral and Bostick 1969]
R. virginica L.

MELIACEAE
Melia azedarach L.

MENISPERMACEAE
Cocculus carolinus (L.) DC.

MENYANTHACEAE
Nymphoides cordata (Elliott) Fernald (UNA)

MORACEAE
Broussonetia papyrifera (L.) Vent.
Fatoua villosa (Thunb.) Nakai
**Maclura pomifera* (Raf.) C.K.Schneid.
Morus rubra L.

MYRICACEAE
Myrica cerifera L.
M. heterophylla Raf.

NYMPHAEACEAE
Brasenia schreberi J.F.Gmel.
Nuphar luteum (L.) Sibth. & Sm.
Nymphaea odorata Aiton

NYSSACEAE
**Nyssa aquatica* L.
**N. sylvatica* Marshall

OLEACEAE
Chionanthus virginicus L.
Forestiera ligustrina (Michx.) Poir. [Clark 1971]
Fraxinus americana L.
F. caroliniana Mill.
Ligustrum japonicum Thunb.
L. sinense Lour.
Osmanthus americana (L.) Benth. & Hook.f. ex A.Gray

ONAGRACEAE
Gaura filipes Spach
G. sinuata Nutt. ex Ser.
Ludwigia alternifolia L.
L. decurrens Walter
L. glandulosa Walter
L. hirtella Raf.
L. leptocarpa (Nutt.) Hara
L. maritima R.M.Harper (UNA)
L. microcarpa Michx.
Oenothera biennis L.
O. fruticosa L.
O. laciniata Hill
O. speciosa Nutt.

OPHIGLOSSACEAE
**Botrychium biternatum* (Sav.) Underw.
B. dissectum Spreng. (UNA)
**B. lunarioides* Michx. T4N, R13E, Sec. 32
B. obliquum (Muhl.) Small [Short 1978]
B. virginianum (L.) Sw.
**Ophioglossum crotalophoroides* Walter T4N, R13E, Sec.32

OROBANCHACEAE
Conopholis americana (L.) Wallr.
Epifagus virginiana (L.) Barton

ORCHIDACEAE
Calopogon tuberosus (L.) Britton, Sterns & Poggenb.
Cleistes divaricata (L.) Ames
**Corallorhiza wisteriana* Conrad
**Epidendrum conopseum* R.Br. T7N, R11E, Sec. 13-14
Listera australis Lindl.
Malaxis unifolia Michx.
Platanthera ciliaris (L.) Lindl.
P. clavellata (Michx.) Luer
P. cristata (Michx.) Lindl.
P. flava (L.) Lindl.
Pogonia ophioglossoides (L.) Ker Gawl.

Spiranthes praecox (Walter) S.Watson
S. tuberosa Raf.
S. vernalis Engelm. & A.Gray
Tipularia discolor (Pursh) Nutt.

OSMUNDACEAE
Osmunda cinnamomea L.
O. regalis L.

OXALIDACEAE
Oxalis dillenii Jacq.
O. florida Salisb. var. *recurva* (Elliott) Ahles
O. rubra J.St.-Hil.
O. stricta L. Our determinations for the yellow-flowered species of *Oxalis* were gained by comparison of our specimens with those at AUA from nearby counties annotated or collected by R. Kral as well available literature cited elsewhere.

PAPAVERACEAE
Argemone albiflora Hornem.
Sanguinaria canadensis L.

PASSIFLORACEAE
Passiflora incarnata L.
P. lutea L.

PENTHORACEAE
Penthorum sedoides L.

PHYTOLACCAEAE
Phytolacca americana L.

PINACEAE
Pinus echinata Mill.
P. elliottii Engelm. [Clark 1971]
P. glabra Walter
P. palustris Mill.
**P. serotina* Michx.
P. taeda L.
**P. virginiana* Mill.

PLANTAGINACEAE
Plantago aristata Michx.
P. lanceolata L.
P. virginica L.

PLATANACEAE
Platanus occidentalis L.

POACEAE
Agrostis hyemalis (Walter) Britton, Sterns & Poggenb.
Andropogon elliottii Chapm.
A. glomeratus (Walter) Britton, Sterns & Poggenb.
A. ternarius Michx.
A. virginicus L.
Anthaenantia rufa (Elliott) Schult.
Aristida dichotoma Michx. var. *curtissii* A.Gray
A. longespica Poir. in Lam.
A. oligantha Michx.
A. purpurascens Poir.
A. simpliciflora Chapm.
A. virgata Trin.
Arundinaria gigantea (Walter) Muhl.
Axonopus affinis Chase
Briza minor L.
Bromus catharticus Vahl
B. japonicus Thunb. ex Murray
B. secalinus L.
Cenchrus echinatus L.
Chasmanthium latifolium (Michx.) H.O.Yates
C. sessiliflorum (Poir.) H.O.Yates
Ctenium aromaticum (Walter) A.W.Wood
Cynodon dactylon (L.) Pers.
Dactylis glomerata L.
Dactyloctenium aegytium (L.) Beauv.
Danthonia sericea Nutt.
Digitaria sanguinalis (L.) Scopoli
Echinochloa crusgalli (L.) Beauv.
Eleusine indica (L.) Gaertn.
Eragrostis tenella (L.) Beauv. ex Roem. & Schult.
E. hirsuta (Michx.) Nees
E. pilosa (L.) Beauv.
E. refracta (Muhl.) Scribn.
Eremochloa ophiuroides (Munro) Hack.
Erianthus giganteus (Walter) Muhl.
Festuca arundinacea Schreb.
Hordeum pusillum Nutt.
Imperata brasiliensis Trin.
Lolium multiflorum Lam.
Luziola bahiensis (Steud.) Hitchc. [Mohr 1901]
Muhlenbergia schreberi J.F.Gmel.
Oplismenus setarius (Lam.) Roem. & Schult.
Panicum aciculare Desv. ex Poir.
P. anceps Michx.
P. boscii Poir.
P. commutatum Schult.
P. flexile (Gatt.) Scribn.
P. texanum Buckley
P. scoparium Lam.
P. sphaerocarpon Elliott
P. virgatum L.
Paspalum floridanum Michx.
P. laeve Michx.
P. notatum Flügge var. *saurae* Parodi
**P. saugetii* Chase This is a new state record for a species previously known only from south Florida and the Greater Antilles (Hitchcock and Chase 1950).
P. urvillei Steud.
Phyllostachys aurea Riviere & C. Riviere
Poa annua L.
Schizachyrium scoparium (Michx.) Nash
S. tenerum Nees

Secale cereale L.
Setaria geniculata (Lam.) Beauv.
Sorghastrum elliottii (C.Mohr) Nash
S. secundum (Elliott) Nash
Sorghum bicolor (L.) Moench
S. halepense (L.) Pers.
S. vulgare Pers.
Sphenopholis obtusata (Michx.) Scribn.
Sporobolus indicus (L.) R.Br.
S. junceus (Michx.) Kunth
Stenotaphrum secundatum (Walter) Kuntze
Tridens flavus (L.) Hitchc.
Tripsacum dactyloides (L.) L.
Triticum aestivum L.
Vulpia octoflora (Walter) Rydb.

PODOSTEMACEAE
Podostemon ceratophyllum Michx.

POLEMONIACEAE
Phlox amoena Sims
P. drummondii Hook.
P. glaberrima L.
P. pilosa L.

POLYGALACEAE
Polygala boykinii Nutt.
P. grandiflora Walter
P. incarnata L.
P. lutea L.
P. nana (Michx.) DC.
P. nuttallii Torr. & A.Gray
P. polygama Walter

POLYGONACEAE
Brunnichia cirrhosa Banks ex Gaertn.
Polygonum hydropiperoides Michx.
Rumex crispus L.
R. hastatulus Baldwin ex Elliott
Tovara virginiana (L.) Raf.

POLYPODIACEAE
Polypodium polypodioides (L.) Walter

PONTEDERIACEAE
Eichornia crassipes (Mart.) Solms
Heteranthera reniformis Ruiz & Pav.
Pontederia cordata L. (UNA)

PORTULACACEAE
Portulaca oleracea L.
P. pilosa L.

POTAMOGETONACEAE
Potamogeton diversifolius Raf. (UNA)

PRIMULACEAE
Anagallis arvensis L.
Lysimachia ciliata L.
L. lanceolata Walter
**Samolus parviflorus* Raf.

PTERIDACEAE
Adiantum capillus-veneris L.
**A. pedatum* L.
Pteridium aquilinum (L.) Kuhn
**Pteris multifida* Poir.

RANUNCULACEAE
**Actaea pachypoda* Elliott
**Anemone berlandieri* Pritz.
**Aquilegia canadensis* L. var. *australis* (Small) Munz T4N, R13E, Sec. 19
Clematis crispa L.
C. reticulata Walter
C. virginiana L.
**Isopyrum biternatum* (Raf.) Torr. & A.Gray T3N, R13, Sec. 2
Ranunculus abortivus L.
R. hispidus Michx.
R. platensis Spreng.
R. recurvatus Poir.
R. sardous Crantz
Thalictrum thalictroides (L.) Eames & B.Boivin
**Xanthorhiza simplicissima* Marshall

RHAMNACEAE
Berchemia scandens (Hill) K.Koch
**Ceanothus americanus* L.
**Rhamnus caroliniana* Walter

ROSACEAE
Agrimonia pubescens Wallr.
Alchemilla microcarpa Boiss. & Reut.
Amelanchier arborea (Michx.f.) Fernald
**Chrysobalanus oblongifolius* Michx.
Crataegus crus-galli L.
C. flabellata (Bosc) K.Koch
**C. flava* Aiton
C. spathulata Michx. [Clark 1971]
Duchesnea indica (Andrz.) Focke
Geum canadense Jacq.
Malus angustifolia (Aiton) Michx.
**Physocarpus opulifolius* (L.) Maxim.
Prunus angustifolia Marshall [Clark 1971]
P. alabamensis C.Mohr [Dean 1961]
P. caroliniana (Mill.) Aiton
P. persica (L.) Batsch [Clark 1971]
P. serotina Ehrh.
P. umbellata Elliott
Pyracantha coccinea Roem.
**Rosa carolina* L.
R. humilis Marshall (ALU)
R. multiflora Thunb. ex Murray
**R. wichuraiana* Crép.
Rubus argutus Link [Clark 1971]
R. betulifolius Small
R. cuneifolius Pursh
R. flagellaris Willd.
R. trivialis Michx. [Clark 1971]
Sorbus arbutifolia (L.) Heynh.

RUBIACEAE
Cephalanthus occidentalis L.
Diodia teres Walter
D. virginiana L.
Galium circaezans Michx.
G. pilosum Aiton
Hedyotis caerulea (L.) Hook.
H. crassifolia Raf.
H. procumbens (Walter ex J.F.Gmel.) Fosberg
H. purpurea (L.) Torr. & A.Gray
H. pusilla Sch_pf
Mitchella repens L.
Richardia scabra L.
RUTACEAE
**Poncirus trifoliata* (L.) Raf.
**Ptelea trifoliata* L.
**Zanthoxylum clava-herculis* L.
SALICACEAE
Populus deltoides Bartram ex Marshall
Salix caroliniana Michx. [Clark 1971]
**S. eriocephala* Michx.
S. nigra Marshall
SAPOTACEAE
Bumelia lanuginosa (Michx.) Pers.
B. lycioides (L.) Pers. [Dean 1961]
SARRACENIACEAE
Sarracenia leucophylla Raf.
S. psittacina Michx. [Freeman et al. 1979]
S. purpurea L.
SAXIFRAGACEAE
Decumaria barbara L.
Hydrangea arborescens L.
H. quercifolia Bartram
Itea virginica L.
Philadelphus inodorus L.
Tiarella cordifolia L.
SCHIZAEACEAE
Lygodium japonicum (Thunb.) Sw.
SCROPHULARIACEAE
Agalinis fasciculata (Elliott) Raf.
A. purpurea (L.) Pennell
A. setacea (Walter) Raf.
Aureolaria flava (L.) Farw.
A. pectinata (Nutt.) Pennell
Bacopa caroliniana (Walter) B.L. Rob. (UNA)
Buchnera floridana Gand.
Gratiola floridana Nutt.
G. pilosa Michx.
Linaria canadensis (L.) Dum.Cours.
Linderia dubia (L.) Pennell
Macranthera flammea (Bartram) Pennell
Mazus pumilus (Burm.f.) Steenis
Mecardonia acuminata (Walter) Small
Micranthemum umbrosum (Walter) S.F.Blake
Mimulus alatus Aiton
**Paulownia tomentosa* (Thunb.) Siebold & Zucc. ex Steud.
Pedicularis canadensis L.
Penstemon digitalis (L.) Aiton
P. laevigatus Sol.
**Scoparia dulcis* L.
Seymeria pectinata Pursh
Verbascum thapsus L.
Veronica arvensis L.
V. peregrina L.
SELAGINELLACEAE
Selaginella apoda (L.) Fernald
S. ludoviciana A.Br. [Short 1978]
SIMAROUBACEAE
Ailanthus altissima (Mill.) Swingle
SOLANACEAE
Petunia × atkinsiana D.Don ex Loudon
Physalis angulata L.
Solanum carolinense L.
SPARGANIACEAE
Sparganium americanum Nutt.
STEMONACEAE
**Croomia pauciflora* (Nutt.) Torr.
STERCULIACEAE
Firmiana platanifolia (L.f.) Marsili
STYRACACEAE
Halesia diptera Elliott
H. parviflora Michx.
Styrax americana Lam.
S. grandifolia Aiton
SYMPLOCACEAE
Symplocos tinctoria (L.) L'Hér.
TAXODIACEAE
**Taxodium ascendens* Brongn.
**T. distichum* (L.) Rich.
THEACEAE
Stewartia malacodendron L. [Clark 1971]
TILIACEAE
Tilia americana L.
TYPHACEAE
Typha latifolia L.
ULMACEAE
Celtis tenuifolia Nutt.
Ulmus alata Michx.
U. americana L.
U. rubra Muhl.
URTICACEAE
Boehmeria cylindrica (L.) Sw.
B. nivea (L.) Gaudin
VALERIANACEAE
Valerianella radiata (L.) Dufr.
VERBENACEAE
Callicarpa americana L.
Glandularia tenuisecta (Briq.) Small
Lantana horrida Humb., Bonpl. & Kunth

Verbena bonariensis L.
V. brasiliensis Vell.
V. halei Small
V. rigida (L.) Spreng.
V. urticifolia L.

VIOLACEAE
Viola affinis Leconte
V. floridana Brainerd In our opinion, at least two (and perhaps three) distinct acaulescent blue violets in the *V. sororia* complex occur in this county. Limited study of Alabama collections by McKinney (1992) causes his treatment to be less than satisfactory for resolving problems of identification in our area, so these determinations are according to Russell (1965).
V. lanceolata L.
V. palmata L.
V. pedata L.
V. primulifolia L.
V. rafinesquii Greene
V. triloba Schwein.
V. villosa Walter
V. walteri House

VITACEAE
Ampelopsis arborea (L.) Koehne
A. cordata Michx.
Parthenocissus quinquefolia (L.) Planch. [Duncan 1975]
Vitis aestivalis Michx.
V. cinerea Engelm. ex Millard
V. rotundifolia Michx.

XYRIDACEAE
Xyris ambigua Beyr. ex Kunth
X. baldwiniana Schult.
X. caroliniana Walter
X. difformis Chapm. var. *difformis*
X. fimbriata Elliott (UNA)
X. iridifolia Chapm.
X. jupicai Rich.
X. platylepis Chapm.
X. scabrifolia R.M.Harper [Freeman, et al. 1979]

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DOCUMENTED CHROMOSOME NUMBERS 1993:2. ADDITIONAL CHROMOSOME COUNTS IN THE MALVACEAE

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ABSTRACT

Chromosome numbers are reported for 29 species of Malvaceae in 13 genera, of which 18 are new reports. The taxonomic implications of these data are discussed.

RESUMEN

Se reporta números cromosómicos para 29 especies de las malváceas en 13 géneros, de las cuales 18 son datos nuevos. La significación taxonómica de estos datos está considerado.

INTRODUCTION

Chromosome numbers have been useful in evaluating generic boundaries and generic and tribal relationships in many families, including the Malvaceae (Bates 1966, 1968, 1976; Bates and Blanchard 1970; Krapovickas 1957, 1969). The opportunity to obtain new counts and verify previous counts (Table 1) permits the extension and revision of previous interpretations of relationships within the Malvaceae.

MATERIALS AND METHODS

All counts were made on samples taken from greenhouse-grown plants, grown from seed samples taken from voucher specimens indicated in Table 1. Voucher specimens are kept in the senior author's herbarium in College Station, Texas; additional duplicates of these collections may also be found in other herbaria, as noted in the table.

Floral buds were fixed in 3:1, 95% ethanol: glacial acetic acid, for a minimum of 24 hr. Prior to preparation of specimens, the buds were rinsed and allowed to

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TABLE 1. Chromosome numbers of selected species of Malvaceae. New counts are indicated with an asterisk (*).

Species	2*n*	Origin	Voucher
Abutilon barrancae M.E. Jones	16*	Mexico. Nayarit	*Téllez 12703*, MEXU
Torrey ex Gray			
Abutilon hulseanum (Torr. & Gray)	14	Mexico. Veracruz	*Tenorio 8588*, MEXU
Abutilon macvaughii Fryx.	14*	Mexico. Jalisco	*Lott 4008*, UCR
Abutilon otocarpum F. Muell.	14*	Australia	*Fryxell 3855*, CANB
Abutilon parishii S. Watson	14*	U.S.A. Arizona	*Van Devender et al. 91-808*, ARIZ
Abutilon sphaerostaminum Hochr.	14*	Mexico. Veracruz	*Nee & Taylor 28790*, NY
Allowissadula floribunda (Schltdl.) Fryx.	16	Mexico	*Jones & Treviño 168*, NY
Anoda abutiloides A. Gray	30	U.S.A. Arizona	*Van Devender et al. 91-959*, ARIZ
Anoda albiflora Fryx.	30*	Mexico. Michoacán	*Fryxell 5012*, NY
Anoda palmata Fryx.	30	Mexico. Jalisco	*Koch & Fryxell 89193*, CHAPA
Batesimalva killipii Krapov.	24*	Venezuela	*Fryxell & Burandt 4393*, F
Batesimalva violacea (Rose) Fryx.	32*	U.S.A. Texas	*Wurdack s.n.*
Cienfuegosia intermedia Fryx.	20*	Mexico. San Luis Potosí	*Jones 147*, NY
Cienfuegosia ulmifolia Fryx.	20	Argentina	*Schulz s.n.*, CTES
Dirhamphis mexicana Fryx.	30*	Mexico. Jalisco	*Lott et al. 4042*, UCR
Fryxellia pygmaea (Corr.) Bates	16	Mexico. Coahuila	*Fryxell 5006*, NY
Hibiscus calyphyllus Cav.	80	Hawaii. Kauai	without coll., seed acc. no. 74s723, Waimea B.G.
Hibiscus citrinus Fryx.	22*	Mexico. Jalisco	*Lott et al. 4083*, UCR
Hibiscus grandidieri Baillon	32*	Madagascar	*Hardy s.n.*, NY
Hibiscus panduriformis Burm. fil.	24	Australia	*Fryxell 4550*, CANB
Hibiscus pentaphyllus F. Muell.	36*	Australia	*Fryxell 4431*, CANB
Horsfordia exalata Fryx.	30*	Mexico. Sonora	*Sanders 4620*, UCR
Pavonia ecostata Fryx. & Koch	56*	Mexico. Jalisco	*Koch & Fryxell 89198*, CHAPA
Phymosia umbellata (Cav.) Kearn.	34	Mexico. Tamaulpas	*Fryxell 4959*, NY
Sida argentina var. *tucumanensis* Hassler ex Rodrigo	14*	Argentina. Salta	*Cristóbal 2079*, CTES
Sida lindheimeri Engelm. & Gray	28	U.S.A. Texas	*Fryxell 4964*, BRIT
Sida rohlenae var. *mutica* (Benth.) Fryx.	14*	Australia	*Fryxell 4428*, CANB
Sphaeralcea ambigua A. Gray	30	U.S.A. California	*Pitzer 197*, UCR
Sphaeralcea reflexa Fryx. et al.	20*	Mexico. Coahuila	*Fryxell et al. 4997*, TEX

soak in tap water or distilled water for several hours. Anthers were dissected from the buds, placed in acetocarmine stain, then cut and macerated to release microsporocytes. Preparations containing microsporocytes at stages suitable for chromosome counting were covered with a coverslip and repeatedly heated and cooled until chromatin was satisfactorily stained. The cells were then squashed, and the coverslips were sealed with wax. Counts were made under oil immersion brightfield or, occasionally, phase-contrast optics on an Olympus Vanox microscope. Sufficiently flat specimens were photographed using Kodak Technical Pan film 2415.

RESULTS AND DISCUSSION

The results of these studies are summarized in Table 1.

Abutilon. Chromosome counts for six species are reported in the genus *Abutilon* (Figs. 1, 2). A previous count for *A. hulseanum* (Bates 1976) is verified, and new reports are presented for the remaining five species. Four of these five have a chromosome number of $2n = 14$, which conforms to the base number of $x = 7$ for the majority of species in the genus. *Abutilon barrancae*, on the other hand, has $2n = 16$. This species represents *Abutilon* sect. *Anasida* (cf. Fryxell 1988, p. 25). Those species that have been or can be placed in this section, and which have been counted, also have chromosome numbers of $2n = 16$, including *Abutilon*

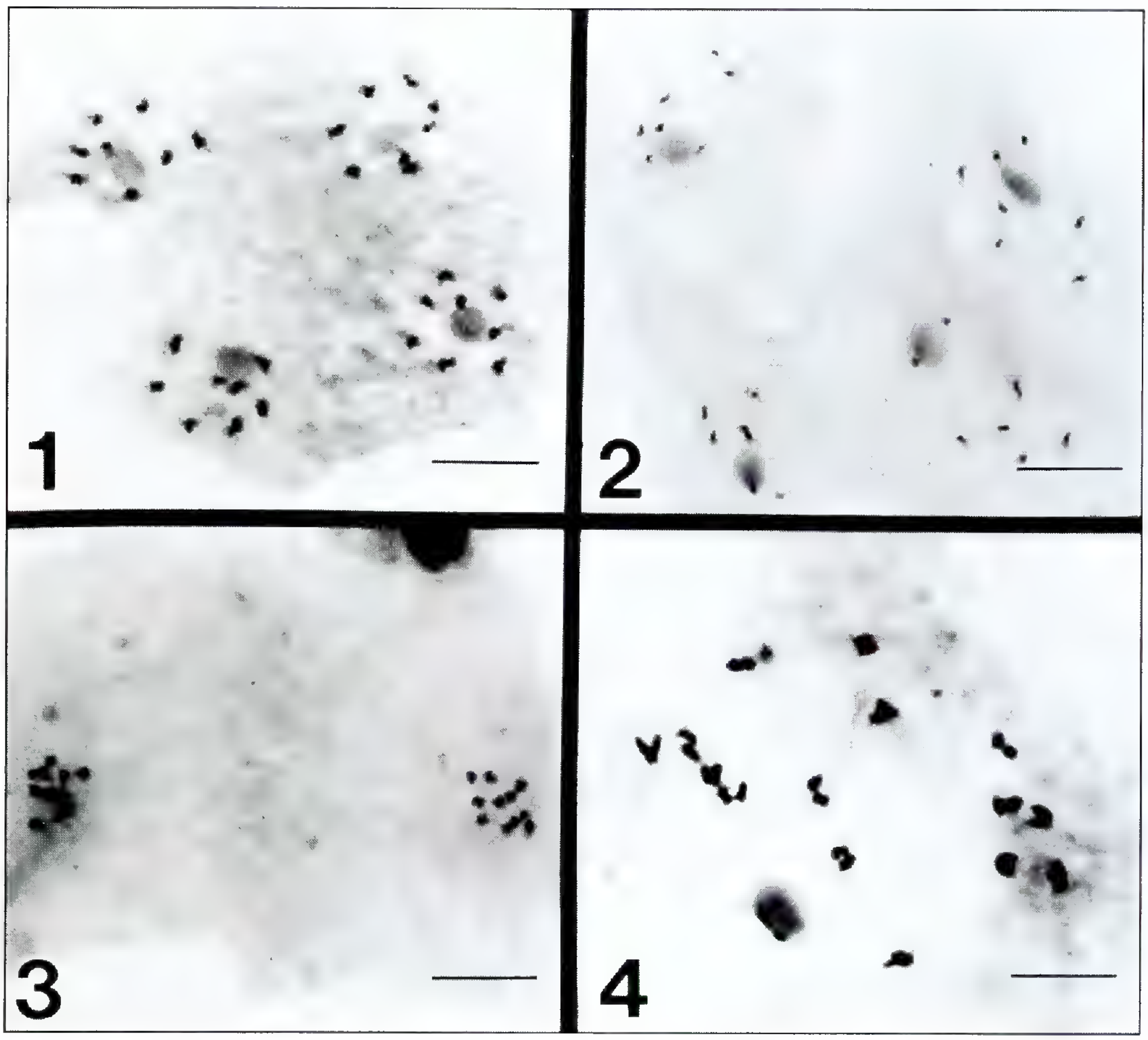


FIG. 1. Microsporocyte of *Abutilon barrancae*: coenocytic sporad stage, showing four nuclei, each with eight chromosomes (bar = 18 μm).

FIG. 2. Microsporocyte of *Abutilon parishii*: coenocytic sporad stage (at early cytokinesis), showing four nuclei, each with seven chromosomes (bar = 20 μm).

FIG. 3. Microsporocyte of *Hibiscus citrinus*: coenocytic dyad stage, each of the two poles having 11 chromosomes (bar = 20 μm).

FIG. 4. Microsporocyte of *Hibiscus grandidieri*: diplotene stage with 16 bivalents, one closely associated with the darkly staining nucleolus (bar = 15 μm).

anderssonianum Garcke, *A. ellipticum* Schltdl., *A. thurberi* A. Gray, *A. umbellatum* (L.) Sweet, *A. virgatum* (Cav.) Sweet, and *Pseudabutilon callimorphum* (Hochr.) R.E. Fries (Bates 1966, 1976; Fernández 1974; Krapovickas 1957). This group of species is clearly distinguished cytologically, a distinction that is supported by morphological characters, and the question must be raised whether sect. *Anasida* merits elevation to generic rank. If so, the name *Pseudabutilon* is available, although several new combinations would be required, and the generic boundaries originally proposed by Fries (1908) would have to be revised. The typification of *Pseudabutilon* was discussed by Fryxell (1988, p. 75), who concluded that the type species is *Pseudabutilon scabrum* (Presl) R.E. Fries [= *Abutilon barrancae* M.E. Jones].

Another group of *Abutilon* species is characterized by a chromosome number of $2n = 16$ (e.g. *A. inaequilaterum* St.-Hil., *A. mueller-friderici* Gürke & Schumann, *A. niveum* Griseb., *A. pictum* (Hooker & Arnott) Walp., *A. purpusii* Standley, *A. regnellii* Miquel, and *A. striatum* Dicks. ex Lindl.), but these may be assigned to *Abutilon* sect. *Pluriovulatae* Fryx. and are outside of the present discussion.

Allowissadula. The count of $2n = 16$ for *Allowissadula floribunda* confirms the previously reported chromosome number for this species (Bates 1978, as *A. microcalyx* (Rose ex R.E. Fries) Bates). Of the nine species of this genus, five are known cytologically, all of which have the same chromosome number.

Anoda. The three species of *Anoda* reported here all have the chromosome number $2n = 30$, which conforms to the known base number for the genus, $x = 15$ (Bates 1987). The values for *A. abutiloides* (Fig. 5) and *A. palmata* are confirmations of previously reported counts (Bates 1987), and the report for *A. albiflora* is new. The latter species is polymorphic for corolla color, and the available seed sample was segregating for white- and lavender-flowered plants. Both flower color forms have the same chromosome number.

Batesimalva. The count of $2n = 32$ for *B. violacea* is new (Figs. 9, 10). Only one previous chromosome count in *Batesimalva* has been reported, also $2n = 32$ for *B. pulchella* Fryx. (Bates and Blanchard 1970, as *Gaya* aff. *violacea*). This species is very similar to *B. violacea*, both morphologically and phytogeographically.

The count of $2n = 24$ for *B. killipii* is also new (Fig. 13) and presents a number that is seldom encountered in the Malvaceae. In the tribe Malveae, counts of $2n = 12$ and 24 have been reported principally in the genera *Gaya* (Krapovickas 1957; Fernández 1974, 1981; Bates 1976) and *Malvastrum* (Hill 1982), as well as from a few species of *Cristaria* (Krapovickas 1957) and *Lecanophora* (Krapovickas 1950). *Batesimalva killipii* cannot be allied with any of these genera, differing substantially from all of them in morphological terms.

At the same time, the chromosome count of $2n = 24$ for *Batesimalva killipii* differs from the counts of $2n = 32$ reported for other species of *Batesimalva* (see previous paragraph), and the two counts are not readily reconciled. Therefore, the generic placement of *B. killipii* is brought into question. The species was

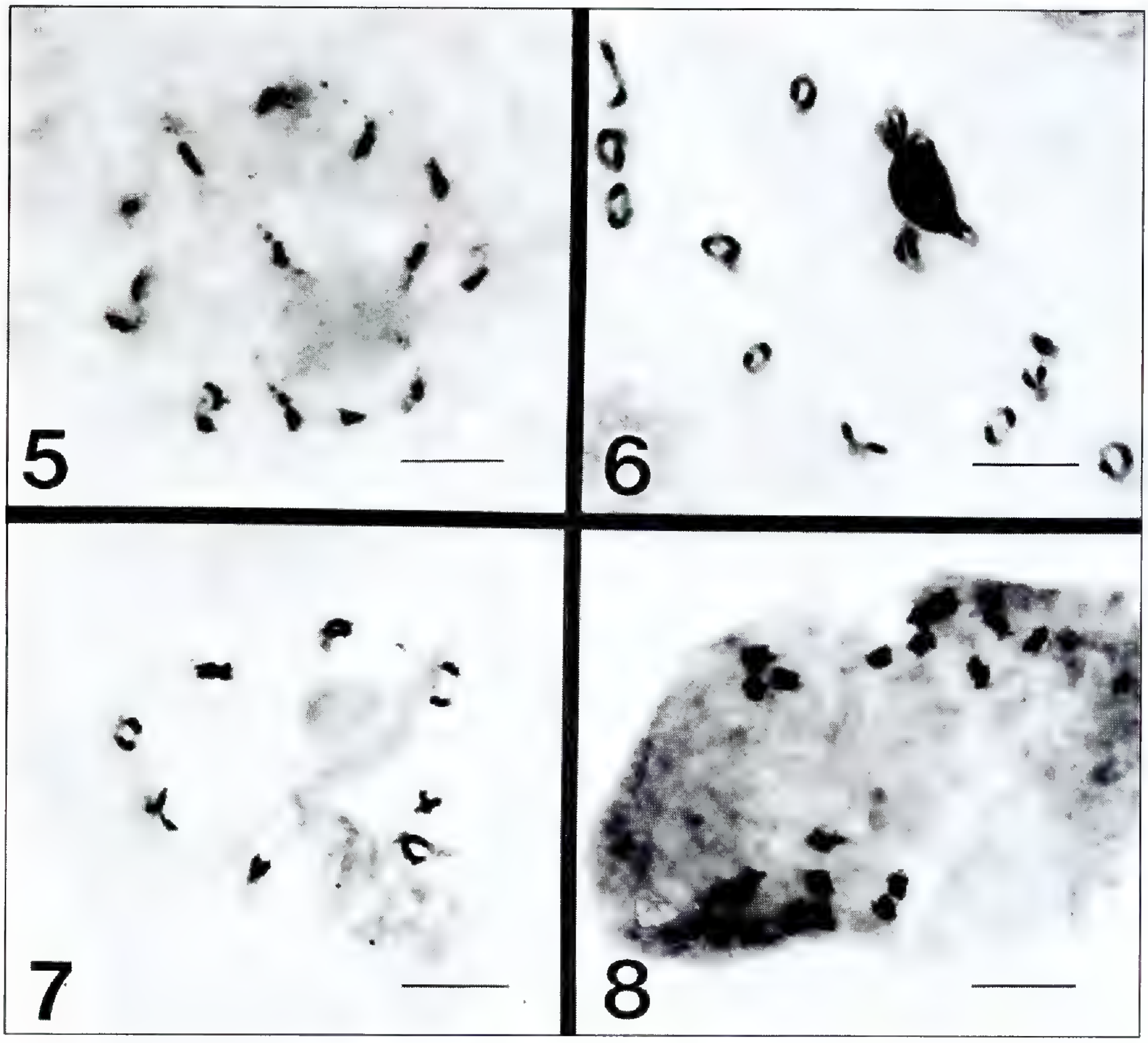


FIG. 5. Microsporocyte of *Anoda abutiloides*: late diplotene stage (nucleolus barely visible), with 15 bivalents at unusual semi-contracted state (bar = 9 μm).

FIG. 6. Microsporocyte of *Dirhamphis mexicana*: diplotene stage, showing 15 bivalents, three attached or partially superimposed on the nucleolus (bar = 16 μm).

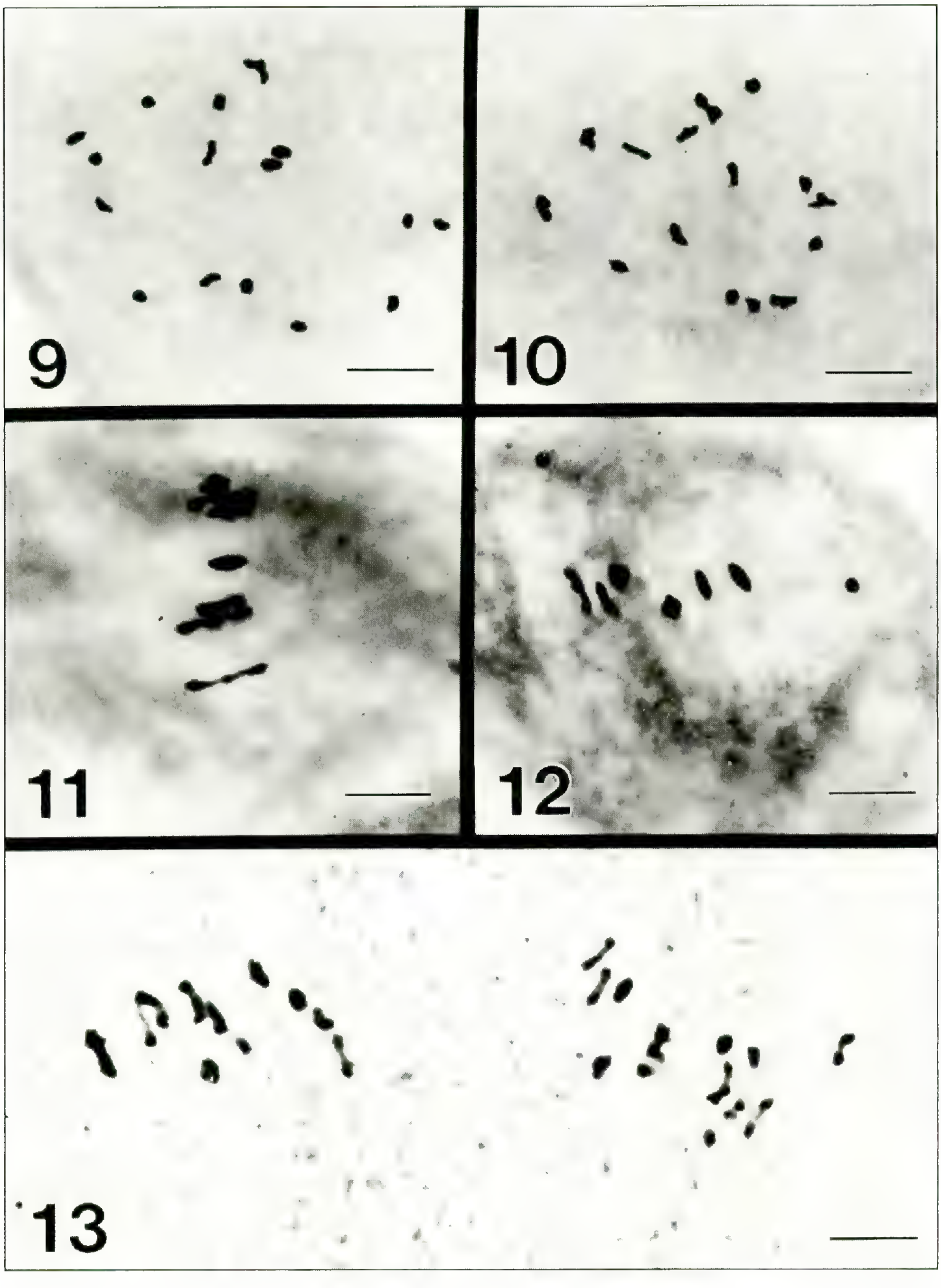
FIG. 7. Microsporocyte of *Fryxellia pygmaea*: diplotene stage, showing 8 bivalents (bar = 16 μm).

FIG. 8. Microsporocyte of *Sphaeralcea reflexa*: telophase I, each pole with 10 chromosomes (bar = 12 μm).

originally placed in *Batesimalva* because it shared features of mericarp morphology with previously known species of the genus, although it differed in floral (and other) characters and in phytogeography. In view of the cytological difference here reported, the generic boundaries of *Batesimalva* will need to be reconsidered, including the possibility of a new generic placement for *B. killipii*.

Cienfuegosia. The chromosome counts of $2n = 20$ for *C. intermedia* is a new report, and the same count for *C. ulmifolia* confirms the report of Palacios and Tiranti (1966). These counts agree with the numbers reported for other American species of this genus that are cytologically known (Wilson and Fryxell, 1970).

Dirhamphis. The chromosome number of $2n = 30$ (Fig. 6) reported here for



FIGS. 9 and 10. Microsporocytes of *Batesimalva violacea*: early metaphase I, with 16 bivalents (bar = 18 µm).

FIGS. 11 and 12. Microsporocytes of *Sida rohlenae* var. *mutica: metaphase* I, with seven bivalents (four "rods" and three "rings") vs. six bivalents (one rod) plus two univalents (off metaphase plate), respectively (bars = 11µm and 13 µm, respectively).

FIG. 13. Two microsporocytes of *Batesimalva killipii*: metaphase I, each with 12 bivalents (bar = 8.9 µm).

D. mexicana is a new report. The other species of the genus, *D. balansae* Krapov., has been reported as $2n = 14$ (Fernández 1981). Fryxell (1988, p. 6) suggested that a group of four genera (*Batesimalva, Horsfordia, Briquetia*, and *Dirhamphis*) constitute a generic alliance, based largely on a commonality in fruit structure, but this view may need to be revised on the basis of chromosome numbers reported here, as discussed further in the following paragraph. Further, because of disparate chromosome numbers, the two species of *Dirhamphis* may not be congeneric.

Fryxellia. The count of $2n = 16$ for *F. pygmaea* (Fig. 7) was previously reported (Fryxell and Valdés 1991) and the cell preparations illustrated. It was suggested that a phylogenetic relationship may exist between *Fryxellia* and *Batesimalva*, which possibly share a common base chromosome number. This finding provides a hypothesis for evaluation using other classes of data. Moreover, the other genera noted above also need to be brought into the discussion. On the basis of chromosome numbers now available, this group may need to be divided into at least two groups, one with $x = 15$ (*Dirhamphis mexicana* and *Horsfordia*) and one with $x = 16$ (*Batesimalva*) or $x = 8$ (*Fryxellia*). *Briquetia* ($x = 7$) may not relate to either group but may be better placed in the *Abutilon* alliance. The position of *Dirhamphis mexicana* and that of *Batesimalva killipii* require further study, but we now have a framework for discussion.

Hibiscus. Chromosome counts for five species are reported here, three of which are new. Previous reports for *Hibiscus panduriformis* (Skovsted 1941; Dasgupta and Bhatt 1976, 1982; Bhatt and Dasgupta 1976; Krishnappa and Munirajappa 1980) have all given the same result as found here, $2n = 24$, even though this species is highly variable morphologically. The count of $2n = 80$ for *H. calyphyllus* conforms to previous counts reported by Skovsted (1941), Niimoto (1966), Kachecheba (1972) and Krishnappa & Munirajappa (1980), but differs from a report of $2n = 40$ by Bates (1966); the species evidently exists at two ploidy levels.

The count of $2n = 22$ for *H. citrinus* (Fig. 3) conforms to similar counts reported for other New World species of *Hibiscus* sect. *Bombicella*, *H. biseptus* S. Wats., *H. denudatus* Benth., *H. martianus* Zucc., and *H. phoeniceus* Jacq. (Skovsted 1935, 1941; Bates 1976), indicating that the American members of this section are cytologically quite uniform.

Chromosome numbers for *Hibiscus* sect. *Bombicella*, the section to which *H. grandidieri* belongs, were reviewed by Fryxell (1980). The count here reported (Fig. 4) for *H. grandidieri* ($2n = 32$) conforms to counts for two other African species of this section (*H. mutatus* N.E. Brown and H. *ferrugineus* Cav.) but differs from the tetraploid count $2n = 64$ for *H. micranthus* L. f. and the count of $2n = 22$ for *H. pusillus* Thunberg. The latter count is the same as that which characterizes the five American species of section *Bombicella* that are known cytologically (Fryxell 1980; see previous paragraph).

The count of $2n = 36$ for *H. pentaphyllus* conforms to the count reported for the similar species *H. caesius* Garcke (Dasgupta and Bhatt 1976, 1982). However, the base chromosome number of $x = 18$ is also characteristic of *Hibiscus* sect. *Furcaria*, where it is known at several ploidy levels (e.g., Menzel & Wilson 1969), a group of species to which *H. pentaphyllus* is clearly not closely related.

Thus it is clear that much remains to be learned about the generic subdivision of *Hibiscus*, a genus of considerable cytological polymorphism.

Horsfordia. This genus contains five species, two of which (*H. alata* (Wats.) Gray and *H. newberryi* (Wats.) Gray) have been reported previously to have 2n = 30 (Bates 1966, 1976), as is reported here for *H. exalata*. The genus appears to be uniform, and it shares a base chromosome number of $x = 15$ with *Dirhamphis mexicana*, as discussed previously.

Pavonia. Chromosome counts for more than 25 species of *Pavonia* have been reported in the literature (Fryxell, in prep.), and all have been at various ploidy levels based on $x = 7$. The new count for *P. ecostata* of $2n = 56$ conforms to this pattern and indicates the species is octoploid. This is the only count yet reported for *Pavonia* subgen. *Malache*. *Pavonia* and *Hibiscus* present an interesting contrast. Both are large genera with more than 200 species, but *Pavonia* is cytologically uniform with a single base number, whereas *Hibiscus* is highly polymorphic with a wide range of base numbers.

Phymosia. The report of $2n = 34$ for *Phymosia umbellata* confirms previous reports for this species (Bates 1976; Skovsted 1935; Webber 1936) and previous counts for other species in the genus, *P. rosea* (DC.) Kearn. (Bates and Blanchard 1970) and *P. abutiloides* (L.) Hamilton (Webber 1936).

Sida. Two of the three counts reported here for *Sida* are new reports. Both *Sida argentina* var. *tucumanensis* and *Sida rohlenae* var. *mutica* have $2n = 14$ (Figs. 11, 12), the most common count reported for species of *Sida*. The tetraploid count of $2n = 28$ for *Sida lindheimeri* confirms a previous count (Krapovickas 1969).

Sphaeralcea. A base chromosome number of $x = 5$ characterizes this genus, and counts of $2n = 10, 20$, and 30 have been reported for various species, including *S. ambigua*, reported here as having $2n = 30$. The count of $2n = 20$ for *S. reflexa* is a new report (Fig. 8).

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DOCUMENTED CHROMOSOME NUMBERS 1993:3 MISCELLANEOUS U.S.A. AND MEXICAN SPECIES, MOSTLY ASTERACEAE

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ABSTRACT

Chromosome counts are reported for 100 collections of flowering plants representing 81 species from the U.S.A., Mexico, Ecuador, and Guatemala: 71 species of Asteraceae, representing 44 genera; 3 species of *Phacelia* (Hydrophyllaceae); 3 species of *Physalis* (Solanaceae); 2 species of *Brazoria* (Lamiaceae); 1 species of *Gilia* (Polemoniaceae); and 1 species of *Gibasis* (Commelinaceae).

The following chromosome counts (Table 1) are documented by specimens deposited at the University of Texas, Austin (TEX). Previously uncounted taxa are represented by an asterisk (*). A double asterisk (**) indicates a new number for the species. Federov (1969) and the standard indices of plant chromosome numbers published since that opus (through 1989; cf. introduction, Goldblatt and Johnson 1991) were consulted to ascertain previous counts for the taxa concerned.

METHODS

Chromosome counts were made from bud material collected in the field and fixed in a modified Carnoy's solution (4:3:1; chloroform, absolute ethanol, glacial acetic acid), using standard squash procedures. A single count of *Chaetopappa effusa* (*N 7521*) was made from somatic cells of meiotic material.

DISCUSSION

The white-headed *Chaenactis fremontii* has been well-documented as having meiotic chromosome counts of n=5 pairs. Such counts presumably derived by aneuploid loss from n=6 pairs in the yellow-headed *C. glabriuscula* (Kyhos, 1965). Our count of n=6 pairs for *C. fremontii* was obtained from a plant growing at the together with *C. stevioides* (within an area of ca 500 square meters), the latter having a count of n=5 pairs. Kyhos (1965) noted that *C. stevioides* and *C. fremontii* only rarely occur together, and that "Within these few local areas of sympatry the distinctiveness of the species is still maintained even though hybridization between them is sometimes frequent." We did not note hybrids between these at the site concerned, but we do believe that our meiotic count for *C. stevioides* was

TABLE 1. Chromosome numbers

Family/Species	Voucher	Chromosome number (2n)
Asteraceae		
Ageratum conyzoides L. var. *conyzoides*	MEX[1] Jalisco:M[2] 1635	40
Ageratum conyzoides var.*latifolium* (Cav.) Johnson	ECU Pastaza:D 6050	ca 40
Alloispermum scabrum (Lag.) H. Rob.	MEX Chiapas:S 3132	32
Aphanostephus riddellii T. & G.	USA Texas:N 7341	10
Aphanostephus skirrhobasis (DC.)Trel. var *skirrhobasis*	USA Texas:N 7342	6
Aphanostephus skirrhobasis var. *thalassius* Shinners	USA Texas:N 7556	6
Arnica foliosa Nutt.	USA California:Z 907	38
Baileya multiradiata Harv. & Gray	USA Arizona:S 3251, 3252	32
Brickellia paniculata ((Mill.) B.L. Rob.	MEX Chiapas:P 1140	18
Chaenactis carphodilia A. Gray	USA California:T 92-2	16
Chaenactis douglasii (Hook.) Hook. & Arn.	USA California:Z 904	12
** *Chaenactis fremontii* A. Gray	USA California:T 92-17	12
Chaenactis stevioides Hook. & Arn.	USA California:T 92-20	10
* *Chaetopappa bellidifolia* (Gray & Engelm) Shinners	USA Texas:N 7298	16
Chaetopappa bellioides (A. Gray) Shinners	MEX Nuevo Leon:M 1694	16
* *Chaetopappa effusa* (A. Gray) Shinners	USA Texas:N 7521	16[3]
* *Chaetopappa effusa* (A. Gray) Shinners	USA Texas:N 7510	16
* *Chaetopappa parryi* (A. Gray)	MEX Coahuila:N 7413	16
* *Coreopsis palidosa* M.E. Jones	MEX Durango:S 3467	24
Dichaetophora campestris A. Gray	MEX Nuevo Leon:N 7552	6
Encelia frutescens A. Gray	USA California:T 92-18	36
* *Erigeron bigelovii* A. Gray	USA New Mexico:W 20870	36
* *Erigeron chiangii* var. *lamprocaulis* Nesom	MEX Coahuila:N 7408	ca 36
Erigeron divergens T. & G.	USA Texas:W 20401	4-7 II+ 19-13 uni
Erigeron divergens T. & G.	USA New Mexico W 20871	36 uni
Erigeron divergens T. & G.	USA New Mexico:W 20899	27 uni
* *Erigeron metrius* Blake	MEX Coahuila:N 7410	54
Erigeron modestus A. Gray	MEX Coahuila:N 7407a	36
Erigeron modestus A. Gray	MEX Coahuila:T 93-134	27 uni
Erigeron tenuis T. & G.	USA Texas:N 7574	18
Erigeron tenuis T. & G.	USA Texas:N 7561	18
Erigeron turnerorum Nesom	MEX Nuevo Leon:N 7538	18
** *Eriophyllum lanosum* (A. Gray) A. Gray	USA California:T 92-19	10 (ring of 4 + 3 pairs)
Fleischmannia obscurifolia (Hieron.) K. & R.	ECU Napo:D 6206	40
Flyriella parryi (A. Gray) K. & R.	MEX Coahuila:N 7416	20
Gaillardia multiceps Greene	USA Texas:T 93-5	68
Grindelia grandiflora Hook.	MEX Coahuila:N 7456	12
* *Grindelia pusilla* (Steyerm.) Nesom	USA Texas:N 7352,7531	12
Heterotheca sp.	USA New Mexico:T 93-18	18
* *Heterotheca gypsophila* B.L. Turner	MEX Nuevo Leon:T 93-157	36
Heterotheca subaxillaris (Lam.) Britt. & Rusby.	MEX Nuevo Leon:T 93-155	18
Hydropectis aquatica (Watson) Rydb.	MEX Durango:S 2790	18
Hymenothrix wislizeni A. Gray	USA New Mexico:Z 893	24
Hymenothrix loomisii Blake	USA Arizona:Z 909	48

TABLE 1. Chromosome numbers (continued)

Family/Species	Voucher	Chromosome number (2n)
* *Jaegeria purpurascens* B.L. Rob.	MEX Durango:S 2788, 2797	18
* *Jaegeria glabra* Rydb. var. *glabra*	MEX Durango:S 3451	18
Lagascea helianthifolia HBK	MEX Jalisco:M 1638	34
Malacothrix glabrata A. Gray	USA California:T 92-22	14
Melanthera nivea (L.) Small	MEX Oaxaca:M 956	30
Monoptilon bellioides (A. Gray) Hall	USA California:T 92-1	16
Pectis papposa Harv. & Gray var. *papposa*	MEX Chihuahua:S 3441	24
Perityle emoryi Torr.	USA California:T 92-5	102
* *Perymenium cualense* B.L. Turner	MEX Jalisco:M 1642	60
* *Porophyllum zimapanum* B.L. Turner	MEX Hidalgo:LW 399	24
Psilostrophe tagetina (Nutt.) Greene	USA Texas:Z 899	32
Senecio flaccidus var. *douglasii* (DC.) B.L. Turner & Barkley	USA California:Z 899	ca 40
Senecio (*Roldana*) *grandifolius* Less.	MEX Chiapas:L 217	60+(6-8 frag.)
* *Senecio* (*Roldana*) *heterogama* Hemsl.	MEX Chiapas:S 3131	60
* *Senecio* (*Roldana*) *sessilifolius* Hemsl.	MEX Durango:S 2807	60
Solidago altissima L.	USA Texas:N 7503, 7507, 7509	36
Solidago altissima L.	USA Texas:N 7505	ca 36
Solidago altissima L.	USA Texas:N 7508	ca 36
Solidago sempervirens L.	USA Texas:N 7504	36
Stenocarpha filiformis (Hemsl.) Blake	MEX Sinaloa:M 1664	16
Stevia salicifolia Cav. var. *salicifolia*	MEX Chihuahua:S 3365	24
* *Tagetes lunulata* Ort.	MEX Durango:S 3468	24
* *Tagetes mulleri* Blake	MEX Nuevo Leon:S 3296	24
Tagetes zypaquierensis HBK	ECU:JP 2901	24
Thelesperma simplicifolia var *macrocarpum* Melchert	MEX Nuevo Leon:T 93-150	60
Townsendia annua Beaman	USA New Mexico:W 20431	18
Trichoptilium incisum A. Gray	USA California:T 92-9	26
Tridax coronopifolia HBK	MEX Hidalgo:LW 396, 398	18
Verbesina crocata (Cav.) Less.	MEX Guerrero:P 1194	34
Verbesina microptera DC.	MEX Nuevo Leon:P 1297	34
* *Verbesina robinsonii* Fern.	MEX Hidalgo:LW 407	34
Vernonia oaxacana Schultz-Bip.	MEX Chiapas:P 1085	34
Viguiera parishii Greene	USA California:T 92-113	36
* *Wedelia scabra* B.L. Turner	MEX Jalisco:M 1634	24
* *Wedelia talpana* B.L. Turner	MEX Jalisco:M 1640	24
Xylorhiza tortifolia (T. & G.) Greene	USA California:T 92-11	12
Commelinaceae		
Gibasis venustula (HBK) D.Hunt	MEX Coahuila:T 93-137	12
Hydrophyllaceae		
Phacelia campanularia ssp. *variformis* Gillett	USA California:T 92-14	22
* *Phacelia crenulata* Torr. var. *crenulata*	USA California:T 92-18	24
** *Phacelia distans* Benth.	USA California:T 92-21	24
Lamiaceae		
Brazoria truncata (Benth.) Engelm. & Gray	USA Texas:MT 14, 15, 17, 18	28
Brazoria scutellarioides Engelm. & Gray	USA Texas:MT 20	20
Polemoniaceae		
* *Gilia purpusii* Brand	MEX Nuevo Leon:T 93-154	18

TABLE 1. Chromosome numbers (continued)

Family/Species	Voucher	Chromosome number (2n)
Solanaceae		
* *Physalis gracilis* Miers	GUA Izabal:MM 1919	24
Physalis hederaefolia A. Gray	MEX Oaxaca:MM 1903	24
** *Physalis hederaefolia* A. Gray	USA Texas: MM 1949	24 & 48
* *Physalis melanocystic* Bitter	MEX Tamaulipas:MM 1940	24

[1] Abbreviations for countries are ECU=Ecuador, GUA=Guatemala, MEX=Mexico, and USA=United States.

[2] Letters before collection numbers pertain to the following collectors:D(Piero Deleprete); L(Alice LeDuc); M(Mark Mayfield); MM(Mahinda Martinez); N(Guy Nesom); P(Alan Prather); JP(Jose Panero); S(Jacqui Soule); T(B. Turner); MT (Matt Turner); W (Richard Worthington); LW (Lindsay Woodruff); Z(Zai-Ming Zhao).

[3] Counted from somatic cells.

correctly determined as n=6 pairs, although it is possible that our count was complicated by irregularities connected with hybridization between these two taxa at this site.

The counts for *Chaetopappa bellidifolia*, *C. effusa*, and *C. parryi* are first reports for each of the species (a previous report for *C. bellidifolia* was in error; see comments in Nesom 1992). With the addition of these counts, 9 species of the genus (of the total 11) are now known to have a base number of x=8. Previous reports of species with x=9 have been erroneous, based largely on misidentifications (Nesom 1992).

The triploid and tetraploid plants identified here as *Erigeron divergens* (collected by Worthington: *W 20401*, El Paso, Co.; *W 20871*, Dona Ana Co., New Mexico; *W 20899*, Dona Ana Co., New Mexico) have woody bases and are clearly perennial, in contrast to more typical forms of the species over most of its range. The irregular meiotic pairing of these plants is reflected in the production of highly sterile pollen, and the successful production of fertile achenes implies that they are almost certainly apomictic. *Erigeron modestus* is probably involved in their parentage (Nesom, pers. comm.). Particularly in this general area (southwest Texas, adjacent New Mexico, and into north-central Mexico), there is a complex of populations with intermediates combining features of *E. divergens*, *E. metrius*, *E. modestus*, *E. flagellaris* A. Gray, *and E. colomexicanus* A. Nelson. *The Coahuilan collections of Erigeron* by Nesom (*7407a* and *7410*) were from a locality where these five species grow in close proximity, with identifiable hybrids in almost every possible combination among them.

The chromosome number of *Erigeron turnerorum* was first reported as n=9 by Turner (1978), who identified it as *E. tenellus* DC., which is closely related.

Previous counts for the mostly white-rayed *Eriophyllum lanosum* have been reported as n=4 (with n=5 for the closely related, mostly yellow-rayed *E. wallacei*).

We interpret our meiotic count as being n=3 II and a ring of 4, hence our suggestion that the count is basically n=5, as occurs in *E. wallacei* (A. Gray) A. Gray, although it is possible that the count is n=4 pairs (3 bivalents and 1 large bivalent about twice the size of the other 3). Out material certainly represents *E. lanosum*, since it has white rays and was collected in a region well within the range of that taxon. (ca. 1 mile south of Needles, California, along highway 95).

The five counts at the tetraploid level for *Solidago altissima* (=*S. canadensis* var. *scabra* Torr.& Gray) were made from plants obtained in southeastern Texas from the same general area that previously reported collections and counts were made (Turner and Zhao 1992). The present counts were made from Brazos Co. (*N 7505* and *N 7507*), Washington Co. (*N 7508*), and Lee Co. (*N 7509*). Except for their slightly smaller heads, these plants are nearly identical to the widespread hexaploid plants of *S. altissima*, but their tetraploid condition supports their recognition as *S. altissima* var. *pluricephala* M.C. Johnston. This tetraploid race was almost certainly formed independently of other tetraploids within the *S. canadensis* complex, which are widely separated both geographically and morphologically (Nesom pers. comm.).

Thelesperma simplicifolia var. *macrocarpum* Melchert (1990) has called attention to the hexaploid (2n=60) nature of this recently described taxon; counts for the var. *simplicifolia* have been 2n=20, 22, 24 or 40.

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We are grateful to Guy Nesom for the identifications and comments upon several genera and to the several botanists who have contributed buds for meiotic study.

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NOTES

CYPERUS SETIGERUS (CYPERACEAE), NEW FOR NEW MEXICO—*Cyperus setigerus* Torr. & Hook. is a robust perennial 6–10 dm tall with stout creeping rhizomes, few leaves situated on the lower third of the culm, and inflorescences usually composed of 9–13 unequally pedunculate spikes bearing pinnately arranged spikelets. The inflorescence is usually subtended by the same number of conspicuously unequal bracts as there are peduncles. The fertile scales are reddish-brown and envelop a trigonous achene.

This species was not reported in New Mexico by Correll and Correll (1972) nor by Martin and Hutchins (1980). There are now three rhizomatous *Cyperus* with trigonous achenes in New Mexico. A key is provided to separate them.

KEY TO RHIZOMATOUS, TRIGONOUS ACHENED, *CYPERUS* OF NEW MEXICO

1. Inflorescence subtended by (2-)3–4(-5) bracts; fertile scales dark-reddish, dark-purplish, or dark-purplish-brown; mature achenes 0.9–1.0 mm wide; tubers rough and in chains with wire-like rhizomes occurring between several tubers ..... *C. rotundus*
1. Inflorescence subtended by 5–13 bracts; fertile scales golden-yellow to reddish-brown; mature achenes 0.4–0.8 mm wide; tubers smooth, not in chains, terminating fleshy rhizomes which do not occur between tubers.
   2. Mature achenes 0.4–0.5 mm wide; inflorescence usually subtended by 9–13 bracts; fertile scales reddish-brown ..... *C. setigerus*
   2. Mature achenes 0.6–0.8 mm wide; inflorescence usually subtended by 5–10 bracts; fertile scales golden-yellow to stramineous ..... *C. esculentus*

Voucher specimen: NEW MEXICO. **Guadalupe Co.**: ca. 2.7 km (1.7 mi) SE on US 84 from its jct. with NM 119 in Dilia; NW side of US 84 and the Pecos River, 27 Jul 1992, *S. & G. Jones 9636* (BRIT/SMU, ctb = Charles T. Bryson's pers. herb., MICH, vem = Vern E. McNeilus's pers. herb., VSC, WARM).

Cyperus setigerus was locally frequent growing along an open mesic disturbed roadside in red sandy clay soil with igneous rock outcrops. The elevation of the site is ca. 1550 m (5090 ft) with the geology being of the Triassic Rocks Formation (TR) (Triassic). Associated species include: *Conyza canadensis* (L.) Cronq., *Bouteloua gracilis* (Kunth in H.B.K.) Lag., *Melilotus indica* (L.) All., *Aristida* sp., and *Cirsium* sp.

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POLYGONUM CAESPITOSUM VAR. *LONGISETUM* (POLYGONACEAE) NEW TO TEXAS—During field searches for rare native plant species in East Texas conducted in the fall of 1992, a weedy species apparently new to the state was encountered in Jasper County. *Polygonum caespitosum* Blume var. *longisetum* (DeBruyn) Stewart was found in moist coarse sand on an alluvial bar in the bed of a small stream coursing through mostly deciduous bottomland forest. This smartweed was not reported for Texas by Correll and Johnston (1970), Johnston (1990), or Hatch et al. (1990). Several distinctive features, including its decumbent habit, lance-ovate upper leaves, long ochraeal bristles, glandless perianth, and trigonous fruits allow ready identification in Godfrey and Wooton (1979). The taxon is illustrated in Gleason (1952).

This native of Asia has been reported in North America from Massachusetts to Illinois and south to Florida and Louisiana (Godfrey and Wooten 1979). First detected in unglaciated Ohio in 1951 (Cusick and Silberhorn 1977), this smartweed is very commonly encountered in that region in a wide variety of disturbed, moist, partially shaded habitats. In Louisiana it has been reported from a parish bordering Texas (MacRoberts 1989), and its discovery in Texas is not unexpected. In at least part of its North American range, *Polygonum caespitosum* var. *longisetum* is now thoroughly naturalized. Additional collections from East Texas should be anticipated; specimens representing earlier collections may already reside in Texas herbaria although none were found at TEX-LL in January 1993.

Voucher specimen: TEXAS. **Jasper Co.:** locally common, with *Phyllanthus urinaria*, in deep moist sand on bars along bank of Big Walnut Creek, edge of mostly deciduous forest on alluvial terrace, just downstream from (W of) Rt. 96 bridge 1.6 mi S of US Rt. 190 (at Jasper), Jasper East Quadrangle, Elev. 175 ft, 30°53'18"N, 93°59'30"W, 5 Nov 1992, *W.R. Carr and D.R. Hernandez 12491* (BRIT-SMU, TEX-LL).

—*William R. Carr and David R. Hernandez, Endangered Resources Branch, Texas Parks and Wildlife Department, 3000 IH-35 South, Austin, TX 78704, U.S.A.*

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CREPIS SETOSA (ASTERACEAE) A NEWLY ESTABLISHED INTRODUCTANT IN CENTRAL TEXAS—Gandhi and Brown (1993) noted that the newly discovered *Crepis zacintha* and three additional adventives of *Crepis* brought to four the number of species of that genus catalogued for Texas. The recently collected species reported here brings to five the number of *Crepis* species which appear to have become established in the state.

Crepis setosa Hall. f. is a widespread weed in fields and waste places at lower elevations throughout Europe, in North and South America, and New Zealand. Babcock and Stebbins (1983) included *C. setosa* in their treatment of "The American species of *Crepis*" but noted that "The only record of this species from our area is a very robust form which was collected at Silverton, Oregon, in 1919." Since that time the species has been collected Oregon by numerous collectors (e.g. *S.F. Blake 10388* LL, from Marion County in 1927; *Moldenke 32064* LL, from Benton County in 1986), and reported from Humboldt County, California in Abrams and Ferris (1960; cf. illustrations p. 605). Fernald (1950) reported *C. setosa* to be "casually introduced in impure seed (alfalfa, clover and hay)..." in the northeastern United States, but stated that it does not persist. Steyermark (1963) noted *C. setosa* to occur in the central United States in cultivated fields, "but apparently the plants do not persist to become established in various places where they have been collected." Patrick et al (1983) reported the collection of *C. setosa* in Greene County, Tennessee in 1979. They concluded that since the species was not included by Cronquist (1980) theirs must be the first report in the southeastern United States.

Crepis setosa differs from other species of *Crepis* reported for Texas in possessing setose ultimate peduncles on involucres, the setae mostly 1.5–2 mm long. *Crepis*

setosa was first collected in Texas in two separate localities in Austin during the spring of 1991 as follows:

Voucher Specimens: TEXAS. Travis Co.: Austin, vacant lot behind Crenshaw's Athletic Club, Balcones Dr. at 45th St., 2 Jun 1991, *V. Hanesworth s.n.* (TEX); Austin, weed in lawn SE corner of S Lamar Ave. and Blue Bonnet St., 9 Jun 1991, *V. Hanesworth s.n.* (TEX)

The plants were collected again at the same sites in 1992 and observed again during the spring of 1993. It is likely that the species will persist as a weed in central Texas. In addition, it is likely that other introductions of the species may have occurred elsewhere in the state, for the two populations are approximately 10 km apart, the former in north Austin, the latter in south Austin, and were apparently established independently.

I am grateful to B.L. Turner for identification of the species concerned and for encouraging me to follow up on its persistence.—*Virginia Hanesworth, Department of Botany, University of Texas, Austin, TX 78713, U.S.A.*

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